COMPREHENSIVE MANAGEMENT PLAN

FOR PUGET SOUND CHINOOK:

HARVEST MANAGEMENT COMPONENT

Puget Sound Indian Tribes

And

The Washington Department of Fish and Wildlife

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Executive Summary

This Harvest Management Plan outlines objectives that will guide the Washington co-managers in planning annual harvest regimes, as they affect listed Puget Sound chinook salmon, for management years 2004 - 2009. These objectives include total or Southern U.S. exploitation rate ceilings, and / or spawning escapement goals, for each of fifteen management units. This Plan describes the technical derivation of these objectives, and how these guidelines are applied to annual harvest planning.

The Plan guides the implementation of fisheries in Washington, under the co-managers' jurisdiction, but it considers the total harvest impacts of all fisheries, including those in Alaska and British Columbia, to assure that conservation objectives for Puget Sound management units are achieved. Accounting of total fishery-related mortality includes incidental harvest in fisheries directed at other salmon species, and non-landed chinook mortality.

The fundamental intent of the Plan is to enable harvest of strong, productive stocks of chinook, and other salmon species, and to minimize harvest of weak or critically depressed chinook stocks. However, the Puget Sound ESU currently includes many weak populations. Providing adequate conservation of weak stocks will necessitate foregoing some harvestable surplus of stronger stocks.

The rebuilding exploitation rate (RER) objectives stated for management units (Table 1) are ceilings, not annual target rates. The objective for annual, pre-season fishery planning is to develop a fishing regime that will exert exploitation rates that do not exceed the objectives established for each management unit. For the immediate future, annual target rates that emerge from pre-season planning will, for many management units, fall well below their respective ceiling rates. While management units are rebuilding, annual harvest objectives will intentionally be conservative, even for relatively strong and productive populations.

To insure that the diversity of genetic traits and ecological adaptation expressed by all populations in the ESU is protected, low abundance thresholds are specified (Table 1). These thresholds are intentionally set above the level at which a population may become demographically unstable, or subject to loss of genetic integrity. If abundance (i.e., escapement) is forecast to fall to or below this threshold, harvest impacts will be further constrained, by Critical Exploitation Rate Ceilings, so that escapement will exceed the low abundance threshold or the ceiling rate is not exceeded.

Rebuilding exploitation rates are based on the most current and best available information on the recent and current productivity of each management unit. Quantification of recent productivity (i.e., recruitment and survival) is subject to uncertainty and bias. The implementation of harvest regimes is subject to management error. The derivation of RERs considers specifically these sources of uncertainty and error, and manages the consequent risk that harvest rates will exceed appropriate levels. The productivity of each management unit will be periodically re-assessed, and harvest objectives modified as necessary, so they reflect current status.

Table 1.Rebuilding exploitation rates (RERs), expressed either as total, southern U.S. (SUS), or pre-terminal southern US (PT SUS) rates, upper management thresholds, and low abundance thresholds for Puget Sound chinook.

Management Unit	RER	Upper Management Threshold	Low Abundance Threshold
Nooksack [1]	Under development	4,000	
North Fork		2,000	1,000
South Fork		2,000	1,000
Skagit summer / fall	50%	14,500	4,800
Upper Skagit summer		8,434	2,200
Sauk summer		1,926	400
Lower Skagit fall		4,140	900
Skagit spring	38%	2,000	576
Upper Sauk		986	130
Cascade		440	170
Siuattle		574	170
Stillaguamish [1]	25%	900	650
North Fork summer		600	500
South Fork & MS fall		300	N/A
Snohomish [1]	21%	4,600	2,800
Skykomish		3,600	1,745
Snoqualmie		1,000	521
Lake Washington	15% PT SUS		
Cedar River [1]		1,200	200
Green	15% PT SUS	5,800	1,800
White River spring	20%	1,000	200
Puyallup fall	50%		500
South Prairie Creek		500	
Nisqually		1,100	
Skokomish	15% PT SUS	3,650 aggregate, 1,650 natural	1,300 aggregate 800 natural
Mid-Hood Canal	15% PT SUS	750	400
Dungeness	10% SUS	925	500
Elwha	10% SUS	2,900	1,000
Western JDF	10% SUS	850	500

[1] thesholds expressed as natural-origin spawners

This Plan will be submitted to the National Marine Fisheries Service (NMFS), for evaluation under the conservation standards of the Endangered Species Act. Criteria for exemption of state / tribal resource management plans from prohibition of the 'take' of listed species, are contained under Limit 6 of the salmon 4(d) Rule (50 CFR 223:42476). The 4(d) criteria advocate that harvest should not impede the recovery of populations, whose abundance exceeds their critical threshold, from increasing, and that populations with critically low abundance be guarded against further decline, such that harvest will not significantly reduce the likelihood of survival and recovery of the ESU. This Plan assures that the abundance of all populations will increase, if habitat conditions improve to support increased productivity, and that the harvest will be conducted more conservatively than required by the ESA.

1. Objectives and Principles

This Harvest Management Plan consists of management guidelines for planning annual harvest regimes, as they affect Puget Sound chinook, for the 2004 - 2009 management years. The Plan guides the implementation of fisheries in Washington, under the co-managers' jurisdiction, and considers the total harvest impacts of all fisheries on Puget Sound chinook, including those in Alaska, British Columbia, and Oregon. The Plan's objectives can be stated succinctly as intent to:

> *Ensure that fishery-related mortality will not impede rebuilding of natural Puget Sound chinook salmon populations, to levels that will sustain fisheries, enable ecological functions, and are consistent with treaty-reserved fishing rights.*

This Plan will constrain harvest to the extent necessary to enable rebuilding of natural chinook populations in the Puget Sound evolutionarily significant unit (ESU), provided that habitat capacity and productivity are protected and restored. It includes explicit measures to conserve and rebuild abundance, and preserve diversity among all the populations that make up the ESU. The ultimate goal of this plan, and of concurrent efforts to protect and restore properly functioning chinook habitat, is to rebuild natural productivity so that natural chinook populations will be sufficiently abundant and resilient to perform their natural ecological function in freshwater and marine systems, provide related cultural values to society, and sustain commercial, recreational, ceremonial, and subsistence harvest.

The co-managers and the Puget Sound Shared Strategy have adopted abundance and productivity goals for each population, which are the endpoint for all aspects of recovery planning, which will include components for management of harvest and hatchery production, and conservation and restoration of freshwater and marine habitat.

In order to achieve recovery, the Harvest Management Plan adopts fundamental objectives and guiding principles. The Plan will:

- **Conserve the productivity, abundance, and diversity** of the populations that make up the Puget Sound ESU.

- **Manage risk.** The development and implementation of the fishery mortality limits in this Plan incorporate measures to manage the risks, and compensate for the uncertainty associated with estimating current and future abundance and productivity of populations. In addition, the 'management error' associated with forecasting abundance and the impacts of a given harvest regime is built into simulating the long-term dynamics of individual populations. Furthermore, the Plan commits the co-managers to ongoing monitoring, research, and analysis, to better quantify and determine the significance of risk factors, and to modify the Plan as necessary to minimize such risks.

- **Meet ESA jeopardy standards**. The ESA standard, as interpreted by the NMFS, is that activities, such as harvest regulated by this Plan, may be exempted from the prohibition of take, prescribed in Section 9, only if they do not "appreciably reduce the likelihood of survival and recovery" of the ESU (50 CFR 223 vol 65(1):173). This Plan meets that standard, not just for the ESU as a whole, but in several respects sets a more rigorous standard for conserving the abundance, diversity, and productivity of each component population of natural chinook within the ESU.

- **Provide opportunity to harvest surplus production from other species and populations.** This Plan provides for continued harvest of sockeye, pink, and coho salmon, as well as the abundant hatchery production of chinook from Puget Sound and the Columbia River This Plan eliminates directed fisheries on depressed Puget Sound chinook but permits incidental catch of these runs in fisheries aimed at other runs with harvestable surpluses. The level of incidental catch is constrained by specific conservative exploitation rate ceilings or other management objectives.

- **Account for all sources of fishery-related mortality**, whether landed or non-landed, incidental or directed, commercial or recreational, and occurring in the U.S. (including Alaska) or Canada, when assessing total exploitation rates.

- **Adhere to the principles of the Puget Sound Salmon Management Plan** (PSSMP), and other legal mandates pursuant to *U.S. v. Washington* (384 F. Supp. 312 (W.D. Wash. 1974), and *U.S. v Oregon*, to ensure equitable sharing of harvest opportunity among tribes, and among treaty and non-treaty fishers.

- **Achieve the guidelines on allocation of harvest benefits and conservation objectives that are defined in the 1999 Chinook Chapter of Annex IV to the Pacific Salmon Treaty.**

- **Ensure exercise of Indian treaty rights**. Indian fishing rights were established by treaties, and further defined by federal courts in *U.S. v Washington.* The exercise of fishing rights by individual tribes is limited to 'usual and accustomed' areas, according to their historical use of salmon resources.

This Harvest Plan affects, primarily, management of Treaty Indian and non-Indian commercial and recreational salmon fisheries in Puget Sound, including net fisheries directed at steelhead. The geographic scope of the Plan encompasses fishing areas south of the Canadian border in the Strait of Juan de Fuca (east of Cape Flattery), and Georgia Strait. The Secretary of Commerce, through the Pacific Fisheries Management Council, is responsible for management of ocean salmon fisheries (i.e. troll and recreational) along the Oregon / Washington coast (i.e. in Areas 1 – 4B, from May through September). As participants in the PFMC / North of Falcon processes, the Washington co-managers consider the impacts of these ocean fisheries on Puget Sound chinook, and may modify them to achieve management objectives for Puget Sound chinook (PSSMP Section 1.3). Fisheries mortality in Alaska, Oregon, and British Columbia is also accounted in order to assess, as accurately as possible, total fishing mortality of Puget Sound chinook. Mortality of Puget Sound chinook in other Washington commercial and recreational fisheries, e.g. those directed at rockfish, halibut, shellfish, or trout, is not directly accounted.

Natural chinook abundance and productivity in Puget Sound is generally depressed, and for some populations, at critically low levels. Therefore, harvest of these populations must be limited, as part of a comprehensive recovery plan that addresses impacts from harvest, hatchery practices, and degraded habitat. Managing salmon fisheries in Washington to achieve this low impact on Puget Sound natural populations requires accounting of all sources of fishery-related mortality in all fisheries. This is not a trivial task since directed, incidental, and non-landed mortality must all be taken into account, and since Puget Sound chinook salmon are affected by fisheries in a large geographical area extending from southeast Alaska to the Oregon coast. However, since the 1980s research has focused on assessing fishing mortality across the entire range of Puget Sound chinook, so a large body of data and sophisticated computer models are available to quantify harvest rates and catch distribution.

The management regime will be guided by the principles of the Puget Sound Salmon Management Plan (PSSMP), and other legal mandates pursuant to *U.S. v. Washington* (384 F. Supp. 312 (W.D. Wash. 1974), and *U.S. v Oregon*, in equitable sharing of harvest opportunity among tribes, and among treaty and non-treaty fishers. The PSSMP is the framework for planning and managing harvest so that treaty rights will be upheld and equitable sharing of harvest opportunity and benefits are realized. The fishing rights of individual tribes are geographically limited to ‘usual and accustomed’ areas that were specifically described by subproceedings of *U.S. v. Washington*. This Plan is based on the principles of the PSSMP that assure that the rights of all tribes are addressed. Allocation of the non-Indian share of harvest among commercial and recreational users is decided by the policy of the Washington Department of Fish and Wildlife.

The 1999 Chinook Chapter to Annex IV of the Pacific Salmon Treaty also limits harvest in many of the fisheries that impact Puget Sound chinook. The abundance-based chinook management framework contained in the Chapter applies fishery-specific constraints to achieve reduced harvest rates when escapement goals for indicator stocks are not achieved (see section V.B.1). This Plan states how the annual fishing regime developed by the co-managers will comply with the PST agreement. Nearly all of the fisheries implemented under this Plan will be directed at the harvest of species other than chinook or directed at strong chinook runs from other regions or strong hatchery chinook runs from Puget Sound. Therefore, nearly all of the anticipated harvest-related mortality to natural Puget Sound chinook will be incidental to fisheries directed at other stocks or species. Consequently, a wide range of management plans and agreements had to be taken into account in developing this plan.

Harvest-related mortality must be assessed in the context of other constraints on chinook survival. Non-harvest mortality is several orders of magnitude greater than the impact of harvest. If an adult female lays 5,000 eggs, and only two to six of those survive to adulthood, the non-harvest mortality rate exceeds 99.9%. Consequently, a small increase in the rate of survival to adulthood has a much greater effect on abundance than reduction of harvest. Increasing productivity, i.e. the recruitment per female spawner, is essential to recovery. Listing of the Puget Sound ESU has engendered a broad effort, shared by federal, tribal, state, and local governments and the private sector, to protect and restore habitat. Therefore, harvest must be managed so as not to impede recovery, if the capacity and productivity of habitat increases

This Plan sets limits on annual fishery-related mortality for each Puget Sound chinook management unit. The limits are expressed either as exploitation rate ceilings, which are the maximum fraction of the total abundance that can be subjected to fishery-related mortality, or natural escapement thresholds, which trigger additional fishery conservation measures Exploitation rate ceilings for complex management units, comprised of more than one populations, were based, to the extent possible, on estimates of productivity for each component. Implementing this Plan requires assessing the effects of fisheries (i.e. the resulting escapement) for individual populations.

The Plan asserts a specific role for harvest management in rebuilding the Puget Sound ESU and its population components. Implementing the Plan will enable attainment of optimum (MSH) escapement for some populations, but for most populations constraint of harvest can only assure that escapement will remain stable and enable the population to persist. Moreover, constraint of harvest will provide increased escapement to take advantage of any increased productivity or capacity, should favorable conditions more favorable to survival occur. However, for a small number of critically depressed populations, harvest constraint cannot assure persistence, though extraordinary measures will be implemented to avoid increasing the risk of their extinction. Specific attention is paid to the projected escapement of all individual populations during annual fishery planning, and harvest restrictions applied where necessary to protect all populations. However, recovery of Puget Sound population depends on improving productivity (i.e., the capacity of freshwater and estuarine habitat, and the survival of embryonic and juvenile chinook in that habitat). Reducing harvest has no effect on productivity, except when such constraint may prevent escapement from falling to the point of biological instability.

The development and implementation of the fishery mortality limits in this Plan incorporate measures to manage the risks and compensate for the uncertainty associated with quantifying the abundance and productivity of populations, where the information is available for such assessment. In addition, the 'management error' associated with forecasting abundance and estimating the impacts of a given harvest regime is built into the simulation of the future dynamics of individual populations, which is the basis for selecting exploitation rate objectives for some units. Furthermore, the Plan commits the co-managers to ongoing monitoring, research and analysis, to better quantify and determine the significance of risk factors, and to modify the Plan as necessary to minimize such risks.

The 2001 and 2003 versions of the Plan (PSIT and WDFW 2001; PSIT and WDFW 2003) responded to the conservation standards of Section 4(d) of the Endangered Species Act (ESA), after Puget Sound chinook were listed as threatened. However, management objectives and tools have been evolving since the early 1990s in response to the declining status of Puget Sound stocks. Concern over the declining status of Puget Sound and Columbia River chinook has motivated conservation initiatives in the arena of the Pacific Salmon Treaty, and of the Pacific Fisheries Management Council (PFMC). Efforts continue within these forums to address the current status of Puget Sound chinook. This Plan as well will continue to evolve as necessary to address changing management requirements and the needs of this fishery resource.

The ESA conservation standard, as implemented by the NMFS in the salmon 4(d) rule, is that activities that involve take of listed chinook, such as harvest regulated by this plan, may be exempted from the prohibition of take, prescribed in Section 9, if they do not "appreciably reduce the likelihood of survival and recovery" (50 CFR 223 vol 65(1):173) of the ESU. This Plan meets that standard, and in several respects sets more rigorous standards for conserving the abundance, diversity and geographic distribution of Puget Sound chinook.

2. Population Structure – Aggregation for Management

This section describes the population structure of the Puget Sound chinook ESU, and how populations of similar run timing are aggregated for the purposes of harvest management in some river systems.

2.1 Population Structure

Puget Sound chinook comprise an evolutionarily distinct unit (ESU) defined by the geographic distribution of their freshwater life stages, life history, and genetic characteristics (Myers et al. 1998). This ESU includes many independent populations. The central intent of this Plan is to manage fishery-related risk, in order to conserve genetic and ecological diversity throughout the ESU, and to apply this standard to all its composite populations. The Chinook Status Review (Myers et al. 1998) designated the ESU to include populations originating from river basins beginning at the Elwha River, in the Strait of Juan de Fuca, continuing east and south through Puget Sound, and north to the Nooksack River. This Plan also includes chinook originating in the Hoko River, in the western Strait of Juan de Fuca.

Puget Sound chinook populations are classified, according to their migration timing, as spring, summer, or fall chinook, but specific return timing toward their natal streams, entry into freshwater, and spawning period varies significantly within each of these 'races'. Run timing is an adaptive trait that has evolved in response to specific environmental and habitat conditions in each watershed. Fall chinook are native to, or produced naturally, in the majority of systems, including the Hoko, lower Skagit, Snohomish, Cedar, Green, Puyallup, Nisqually, Skokomish, and mid-Hood Canal rivers, and in tributaries to northern Lake Washington. Summer runs originate in the Elwha, Dungeness, upper Skagit, lower Sauk, Stillaguamish, and Skykomish rivers. Spring (or 'early') chinook are produced in the South and North Forks of the Nooksack River, the upper Sauk River, Suiattle River, and Cascade River in the Skagit basin, and the White River in the Puyallup basin.

Puget Sound chinook populations were formerly identified in the Salmon and Steelhead Stock Inventory (WDF et al. 1993); the 2001 Harvest Plan was generally based on the SASSI designation. This Plan conforms with the Puget Sound Technical Recovery Team's (TRT) more recent population delineation (Ruckelshaus et al. 2004) that was developed as part of recovery planning. The Plan omits some populations that were included in the SASSI, either because recent assessment concludes that they are extinct, or that they exist only due to artificial production in the drainage, or as strays from other natural populations or hatchery programs. These include fall chinook in the Samish River, Gorst Creek and other streams draining into Sinclair Inlet, White River, Deschutes River, and several independent tributaries in South Puget Sound, which are only present due to local hatchery programs. Spring chinook in the Snohomish, Nisqually, Skokomish, and Elwha systems are extinct; spring chinook are no longer produced at Quilcene National Fish Hatchery.

The freshwater life history of most Puget Sound chinook populations primarily involves short freshwater ('ocean-type') residence following emergence (i.e. juvenile fish transform into smolts and emigrate to the marine environment during their first year). A small (less than 5 percent) proportion of juvenile fall chinook, and a larger and variable proportion of juvenile spring and summer chinook in some systems rear in freshwater for 12 to 18 months before emigrating, but expression of this 'stream-type' life history is believed to be influenced more by environmental factors than genotype (Myers et al. 1998).

The oceanic migration of Puget Sound chinook typically extends up from the Washington coast as far north as southeast Alaska, with a large, for some stocks a majority, of their harvest taken in the southern waters of British Columbia. Adult chinook generally become sexually mature at the age of three to six years, although a small proportion of males ('jacks') may mature precociously, at age-two. Most Puget Sound chinook mature at age-3 or age-4.

Freshwater life history and maturation rates for Puget Sound chinook populations were reviewed extensively in the Status Review (Myers et al. 1998).

Puget Sound chinook are genetically distinct and uniquely adapted to the local freshwater and marine environments of this region. Retention of their unique characteristics depends on maintaining healthy and diverse populations. A central objective of the Plan is to assure that the abundance of each population is conserved, at a level sufficient to protect its genetic integrity.

The most recent allozyme-based analysis of the genetic structure of the Puget Sound ESU indicates six distinct population aggregates – North and South Fork Nooksack River early, Skagit / Stillaguamish / Snohomish rivers, south Puget Sound and Hood Canal summer / falls, White River springs, and Elwha River (Ruckelshaus et al. 2004). Adult returns to South Sound and Hood Canal are influenced by large-scale hatchery production that utilized common original broodstock (primarily from the Green River), so their apparent genetic similarity may not have been true of indigenous populations. However analysis of samples collected from 33 spawning sites indicate that, with few exceptions, allele frequencies are significantly different, and that spatial or temporal isolation of spawning populations has maintained genetic distinctiveness, even among similar-timed populations within a watershed.

Life history traits were also useful in delineating natural population structure within Puget Sound. In order to determine the current population structure, the TRT (Ruckelshaus et al. 2004) examined juvenile freshwater life history, age of maturation, spawn timing, and physiographic characteristics of watersheds. Chinook also spawn naturally in other areas that may or may not have supported self-sustaining populations historically. Occurrence in these areas is thought be a consequence of straying from nearby natural systems or returns from hatchery programs. The most notable examples are in South Puget Sound, e.g. streams draining into Sinclair Inlet, and the Deschutes River entering Budd Inlet.

2.2 Management Units

A population is a biological unit. A management unit, in contrast, is an operational unit, whose boundaries depend on the fisheries acting on that unit. Salmon management units can range in size from something as large as the West Coast Vancouver Island (WCVI) coho run, which was managed as one unit in the WCVI troll fishery, to something as small as the males that return to a particular hatchery release site.

Prior to the conclusion of *U.S. v Washington* in 1974, almost all fisheries on Puget Sound salmon were conducted in marine waters, with no explicit management units or escapement goals. The Boldt Decision, however, encouraged the development of significant tribal fisheries at the mouths of Puget Sound rivers, and required the development of spawning escapement goals for each management unit. This left the co-managers (and the court) with the task of defining what the management units would be. It was now possible, with significant fisheries at the mouths of rivers, to manage for separate escapement goals for units returning to areas as small as a separate river system. However, unless there were differences in run timing between groups of fish, it was not possible to manage separately for finer units without perpetually wasting large numbers of harvestable fish. Therefore, the court-ordered PSSMP prescribed that management units would not be established for units smaller than a system that flows into saltwater, unless component populations exhibit a difference in migration timing, or as otherwise agreed by the co-managers. With this understanding, the co-managers defined the natural chinook management units in Puget Sound (Table 2), conforming, with the exception of the Mid-Hood Canal unit, to the TRT population delineation. The default escapement goal for these natural management units was maximum sustained harvest (MSH) escapement.

Table 2. Management units for natural chinook in Puget Sound.

Management Unit	Component Populations (category)
Nooksack Early	North Fork Nooksack River (1 South Fork Nooksack River (1)
Skagit Summer / Fall	Upper Skagit River Summer (1) Lower Sauk River Summer (1) Lower Skagit River Fall (1)
Skagit Spring	Upper Sauk River (1) Siuattle River (1) Upper Cascade River (1)
Stillaguamish	North Fork Stillaguamish River Summer (1) South Fork & mainstem Stillaguamish River Fall (1)
Snohomish	Skykomish River Summer (1) Snoqualmie River Fall (1)
Lake Washington	Cedar River Fall (1) North Lake Washington Tributaries Fall (2)
Green	Green River Fall (1)
White	White River Spring (1)
Puyallup	Puyallup River Fall (2)
Nisqually	Nisqually River Fall (2)
Skokomish	North and South Fork Skokomish River Fall (2)
Mid-Hood Canal [1]	Hamma Hamma River Fall (2) Duckabush River Fall (2) Dosewallips River Fall (2)
Dungeness	Dungeness River Summer (1)
Elwha	Elwha River Summer (1)
Western Strait of Juan de Fuca [2]	Hoko River Fall (1)

[1] The three rivers comprise one population.
[2] The western Strait of Juan de Fuca management unit is not part of the listed Puget Sound ESU.

For the next several years, management units were the smallest units considered in management of fisheries in Puget Sound. Then, in the early 1990s, the co-managers undertook the Wild Salmonid Restoration Initiative. As part of this initiative, they published a list, known as SASSI, of all the identified or hypothesized separate salmon populations in Washington, and their status. For chinook, some of these populations were the same as the existing management units, and some were smaller components of management units. Guided by this list, the co-managers then developed a Wild Salmonid Policy (WDFW et al. 1997), which was intended to review and revise as necessary the existing management objectives. Although the Wild Salmonid Policy was not adopted by all the tribes, there was agreement to accept the genetic diversity performance standard:

"*No stocks will go extinct as a result of human impacts, except in the unique circumstance where exotic species or stocks may be removed as part of a specific genetic or ecological conservation plan*."

Of the 15 management units covered in this Plan (Table 2), six contain more than one population. The other nine management units each consist of one population This Plan includes management measures intended to conserve the viability of all populations (see Chapter 6, and the management unit profiles for Skagit, Stillaguamish, and Snohomish in Appendix A). . This significant change in management means that management units are no longer the smallest units considered in management of Puget Sound fisheries. It does *not* mean that separate populations must be managed for the same objective as the management units (i.e., MSH escapement). It means that each separate population is managed to avoid its extinction.

The availability and quality of data to inform management of individual populations varies widely. For some populations, the only directly applicable data are spawning escapement estimates. In such cases, estimates of migratory pathways, entry patterns, age composition and maturation trends, age at recruitment, catch distribution and contributions must be inferred from the most closely related population for which such information is available. Obtaining the information to test and evaluate these inferences and assumptions is one of the key data needs identified in Chapter 7 of this Plan.

This Plan includes specific conservation measures for all populations within management units. However, it does not require that fisheries be managed to achieve the same objectives for each component population within a management unit (e.g., MSH escapement).

3. Status of Management Units and Derivation of Exploitation Rate Ceilings.

In this Plan, each management unit is classified according to its category and its abundance. The category determines the priority placed on recovery of that unit; the abundance determines the allowable harvest, depending on the category.

3.1 Management Unit Categories

The co-managers' Comprehensive Management Plan for Puget Sound chinook categorizes management units according to the presence of naturally produced, indigenous populations, the proportional contribution of artificial production, and the origin of hatchery broodstock.

- Category 1 units consist of native stocks that are predominantly naturally produced, or enhanced to a greater or lesser extent by hatchery programs that rear indigenous chinook.

- Category 2 units are predominantly of hatchery origin, in some cases comprised of non-indigenous broodstock, but where remnant indigenous populations may still exist, and where the habitat is capable of supporting self-sustaining natural production.

- Category 3 units are designated where production occurs only because of returns to a hatchery program, or due to straying from adjacent natural populations or hatchery programs. This Plan does not state harvest objectives for Category III units.

Conservation of Category 1 populations is the first priority of this plan, because they comprise genetically and ecologically essential and unique components of the ESU. The harvest management objectives for these units are set such that their recovery is not impeded, and the risk of decline in their status is very low. They include populations in the Nooksack, Skagit, Stillaguamish, Snohomish, Cedar, Green, White, Dungeness, Elwha, and Hoko rivers (Table 2). Hatchery supplementation is considered to be essential to protecting the genetic and demographic integrity of populations in the Nooksack, Stillaguamish, White, Dungeness, and Elwha rivers. Hatchery production in these systems is included in the ESA listing, because it deems essential to the recovery of the ESU (NMFS 1999).

Natural populations in the North Lake Washington tributaries, and the Puyallup, Nisqually, Skokomish, and mid-Hood Canal rivers have been heavily influenced by artificial production, in most cases based on non-indigenous stocks, and are, therefore, Category 2 management units. This influence persists, even in cases where artificial production may have been redesigned, scaled down, or terminated. Some Puget Sound stocks, most notably from the Green River, have been disseminated into several of these systems, and into the Snohomish system.

Past hatchery programs, frequently using non-indigenous stocks, were managed without informed consideration of the risk to indigenous populations, particularly when viewed in the light of current understanding of the ecological and genetic interactions of natural and hatchery production. Their primary goal was to enhance fisheries. Hatchery production was seen as a solution to increasing demand for fishing opportunity, particularly following the resolution of *U.S. v. Washington*, and the rapid urban growth around Puget Sound. This approach was also perceived to mitigate for severe and continuing habitat losses, including those from hydropower development, irrigation and other withdrawals, agricultural and forest practices, to name a few.

The policy intent was to fully utilize this increased hatchery production, and manage harvest primarily to achieve sufficient escapement to meet the broodstock requirements of the hatchery programs. The potential for restoring natural production in these systems was low, because of degraded habitat. The resulting high exploitation rates were not sustainable by the native, natural chinook populations.

This Plan emphasizes conservation of Category 2 populations, in order to assure their continued viability. In some cases, large-scale hatchery enhancement programs operate in these systems, and hatchery returns contribute significantly to natural spawning. There is continued focus on quantifying the capacity of habitat in these rivers, and the current productivity of naturally spawning chinook. Until the results of these studies are credible, constraint of harvest will assure stable natural escapement, and in some cases provide variable increasing escapement in excess of the interim escapement goals. Where hatchery programs have been implemented specifically as mitigation for habitat loss, e.g. in the Nisqually River and Skokomish River, where habitat loss has resulted in greatly reduced fishing opportunity, harvest may take priority over increasing escapement beyond the level of assuring persistence, until the capacity of habitat is clearly defined, or functional habitat is restored. Assuring the viability of all these populations now preserves future options to manage for higher natural-origin production later, should those populations be deemed essential to a recovered ESU.

Specific harvest objectives have not been established for Category 3 populations in this Plan, so their status is not discussed here in detail. Hatchery programs have been established on systems where there is no evidence of historical native chinook production. In these areas, terminal harvest is frequently managed to remove a very high proportion of the returning chinook, in excess of the broodstock required to perpetuate the program. However, if the harvest falls short of this objective, excess adults may spawn naturally, or be intentionally passed above barriers to utilize otherwise inaccessible spawning areas. Straying into adjacent streams is also likely under this condition. While some natural production may occur in these systems, the available habitat is not suitable to enable sustained production without the continued infusion of hatchery returns or strays.

3.2 Abundance Designations

This Plan classifies Puget Sound chinook management units into two abundance classifications: those that usually have harvestable surpluses, and those that usually don't. For those units without harvestable surpluses, the management units and their component populations are further classified by whether their abundance exceeds or is lower than their low abundance threshold. These abundance classifications are used to set the maximum allowable fishery-related mortality (see Implementation – Chapter 5).

3.2.1 Abundances with Harvestable Surpluses

The co-managers will establish an upper escapement level (hereafter, the 'upper management threshold'), as the threshold for determining whether a MU has harvestable surplus. Consistent with the PSSMP, this threshold will be the escapement level associated with optimum productivity (i.e. maximum sustainable harvest (MSH), unless a different level is agreed to. After factoring in expected Alaskan catches, Canadian catches, and incidental, test, and ceremonial and subsistence catches in southern U.S. fisheries, if an MU is expected to have a spawning escapement greater than the upper management threshold, that MU will be classified as having harvestable surplus

Derivation of Upper Management Thresholds

The upper management threshold was calculated for some MUs (Skagit summer - fall, Skagit spring, Stillaguamish, and Snohomish) under current habitat conditions. The method used to calculate current productivity depends on the data available for that MU. Some MUs have data on spawning escapement, juvenile production, habitat measurements, CWT distribution, and adult recruitment; other units may have data only on escapement and terminal run size; and other units may have only index escapement counts and terminal area catches. The method used for each MU is described in its Management Unit Profile (Appendix A). Once the current productivity and capacity are calculated, the upper management threshold, depending on how it is defined, can be estimated from such methods as standard spawner-recruit calculations (Ricker 1975), empirical observations of relative escapement levels and catches, or Monte Carlo simulations that buffer for error and variability (Hayman 2003).

For other MUs, the upper management threshold was set as the current escapement goal. In some cases this level is the best available estimate of current MSH escapement. In other cases (e.g. Nooksack, Puyallup, Nisqually, Skokomish, Mid Hood Canal, and Dungeness) the current escapement goal is substantially higher than current MSH level, according to habitat-based analysis of current productivity.

Establishing the current MSH escapement level, or a buffered surrogate, as the upper management threshold is a conservative standard that assigns harvest management its rightful share of the burden of conservation, assures long-term increases in abundance, and does not impede recovery. As habitat conditions improve, this threshold can be increased to account for increased productivity or capacity (see Chapter 7, Plan Review).

3.2.2 Abundances With No Harvestable Surpluses

A MU that is projected to have a spawning escapement below its upper management threshold lacks harvestable surplus. Under this plan, no commercial or sport fisheries in Puget Sound can be conducted that target on MUs without harvestable surplus (see Application to Management section). Moreover, incidental impacts on each MU must be less than the specified ceiling rebuilding exploitation rate (RER). This ceiling is further reduced if the abundance of any MU, or a component population of a MU, is below a specified low abundance threshold (LAT).

Derivation of Rebuilding Exploitation Rates

Rebuilding exploitation rates were established for the Skagit summer / fall, Skagit spring, Stillaguamish, and Snohomish management units after simulating the future dynamic abundance of each unit under a range of exploitation rates. The RER is the highest exploitation rate that met the most restrictive of the following risk criteria:

- A very low probability (less than five percentage points higher than under zero harvest) of abundance declining to a calculated point of instability; and either

- A high probability (at least 80%) of the spawning escapement increasing to a specified threshold (see MU Profiles in Appendix A for details), **or** the probability of escapements falling below this threshold level differs from a zero harvest regime by less than 10 percentage points.

The simulation models relied on detailed information about the current productivity of the populations in question, including estimates of annual spawning escapement, maturation rates, harvest-related mortality that enable reconstruction of historical cohort abundance, and variability in marine and freshwater survival. With initial escapement and annual exploitation rate specified, the simulation predicts recruitment, harvest mortality, and escapement, for 25 years, under variable marine and freshwater survival and management error typical of recent years. Management error includes the differences between anticipated and actual chinook catch, changes in the harvest distribution of contributing stocks, and error in forecasting abundance.

The essential data, and the methods used for derivation of the recruitment functions, upper and lower threshold values, and selection of the RER, for each of the four management units, are detailed in Appendix A.

Risk tolerance criteria were chosen subjectively, through joint technical cooperation by tribal, state, and federal biologists, as adequately conservative for depressed chinook populations; they were not specified as jeopardy standards in the NMFS' salmon 4(d) rule. Upper and lower escapement criteria were derived by various methods, which are detailed in Appendix A. The upper 'rebuilding escapement threshold' is not equivalent, for all management units, the upper management thresholds which defines harvestable abundance. The lower 'critical abundance threshold' is not equivalent to the low abundance threshold applied as an indicator of critical status for management purposes.

The simulations indicate that the conservative risk criteria will be met if actual annual target exploitation rates are at the level of the RER. However, this Plan envisions actual annual exploitation rates to be less than the RER, for some units by substantial margins (see Table 12, Chapter 6), so the actual probability of increasing abundance is expected to exceed the 80% / 10% criteria, and the actual probability of falling to the point of instability is expected to be less than 5% higher than under zero harvest.

For units without such data, the ceiling rates were set with reference to observed minimum rates, or harvest ceilings set by the Pacific Salmon Treaty (see Appendix A). For these management units, total or southern U.S. (SUS, i.e., due to Washington and Oregon fisheries) exploitation rate ceilings are generally established at the low level of the late 1990s, which resulted in stable or increasing spawning escapement. These ceilings are usually SUS exploitation rates between 10 and 20 percent. Since this Plan eliminates fisheries targeted at MUs without harvestable abundance, these ceilings allow the spawning escapements for these units to benefit from the recent reductions in Canadian and U.S. fisheries, in some cases providing terminal runs that exceed the upper management threshold.

Derivation of Low Abundance Thresholds

Demographic and genetic theory indicates that when the spawning abundance of a salmon population falls to a very low level, there is a significant increase in the risk of demographic instability, loss of genetic integrity, and extinction. This level, termed the point of biological instability, has not been quantified for all salmon populations, but genetic and demographic theory has drawn its boundaries (McIlhaney et al. 2000). At low spawner abundance, ecological and behavioral factors can cause a dramatic decline in productivity. Low spawner density can affect spawning success by reducing the opportunity for mate selection, or finding suitable mates. Depensatory predation can significantly reduce smolt production. However, the level at which these factors exert their effect will differ markedly between populations.

The low abundance threshold (LAT), which triggers extraordinary conservation measures in fisheries (Table 3), is set well above the point of instability, so that harvest mortality can be constrained, severely if necessary, to prevent populations from becoming unstable. The derivation of the LAT varied, according to the data available for each population. In some cases, the threshold was set at or above an historical low escapement from which the population rebounded (i.e. survivors from that low brood escapement produced a higher number of subsequent spawners). In other cases, where spawner-recruit and management error data were deemed sufficient, we calculated a threshold at which the probability of falling below the calculated point of instability was acceptably low. In other cases, where specific data were lacking, we used values from the literature that estimated minimum effective population sizes that would avoid demographic instability or loss of genetic integrity (e.g., Franklin 1980; Waples 1990; Lande 1995; McElhany et al. 2000).

For example, thresholds for Skagit summer and fall populations were calculated as the forecast escapement level for which there is a 95 percent probability that actual escapement will be above the point of instability (i.e., 5 percent of the replacement escapement level). This calculation accounted for the difference between forecast and actual escapement in recent years, and the variance around recruitment parameters. For the Stillaguamish management unit, escapement of 500 was identified as the low abundance threshold, because this level has resulted in recruitment rates of 2 – 5 adults per spawner. For other Puget Sound populations the low abundance threshold was set in accordance with the scientific literature, or more subjectively, at annual escapement of 200 to 1,000 (see Appendix A).

3.3 Response to Critical Status

This harvest Plan is designed to constrain fisheries impacts on all listed Puget Sound management units by eliminating all but a few fisheries directed at listed chinook. The only directed fisheries, defined as those where a majority of encounters are listed chinook, are a few tribal ceremonial and subsistence fisheries with small harvests, or terminal fisheries targeting management units with fixed escapement goals where harvestable surpluses have been identified. If abundance declines, and the spawning escapement for any population or management unit is projected to fall to or below its low abundance threshold, the co-managers will implement extraordinary restrictions on SUS fisheries to increase the spawning escapement above the low threshold, or reduce the SUS exploitation rate to or below a specified ceiling level.

This response results in a significant reduction in incidental impacts on listed chinook, but preserves minimal harvest access to surplus production of non-listed chinook, and other salmon species. The response to critical status describes exploitation rate ceilings and fisheries that provide minimally acceptable access to sockeye, pink, chum, coho, and chinook salmon for which harvestable surpluses have been identified.

This response to critical status is intended to prevent further decline in abundance, toward the point of biological instability. Restriction of harvest will not, by itself, enable recovery of populations that have suffered severe decline in abundance, resulting from loss and degradation of properly functioning chinook habitat conditions. Restriction of fishing below the level defined in this critical response would effectively eliminate treaty and non-treaty opportunity on non-listed species and populations, without ensuring recovery. If further resource protection is necessary, it must be found by reducing exploitation rates in mixed-stock fisheries north of Washington State in Canadian and Alaskan fisheries, improving habitat conditions, and/or providing artificial supplementation where necessary and appropriate.

Table 3. Rebuilding exploitation rates, low abundance thresholds and critical exploitation rate ceilings for Puget Sound chinook management units.

Management Unit	Rebuilding Exploitation Rate	Low Abundance Threshold	Critical Exploitation Rate Ceiling
Nooksack	Under development		7% / 9% SUS [3]
North Fork		1,000 [1]	
South Fork		1,000 [1]	
Skagit summer / fall	50%	4,800	15% SUS even-years 17% SUS odd-years
Upper Skagit summer		2200	
Sauk summer		400	
Lower Skagit fall		900	
Skagit spring	38%	576	18% SUS
Upper Sauk		130	
Upper Cascade		170	
Suiattle		170	
Stillaguamish	25%	650 [1]	15% SUS
North Fork Summer		500 [1]	
South Fk & MS Fall		N/A	
Snohomish	21%	2,800 [1]	15% SUS
Skykomish		521 [1]	
Snoqualmie		1745 [1]	
Lake Washington	15% PT SUS		12% PT SUS
Cedar River		200 [1]	
Green	15% PT SUS	1,800	12% PT SUS
White River spring	20%	200	15% SUS
Puyallup fall	50%	500	12% PT SUS
Nisqually	Terminal fishery managed to achieve 1,100 natural spawners		
Skokomish	15% PT SUS	1,300 [2]	12% PT SUS
Mid-Hood Canal	15% PT SUS	400	12% PT SUS
Dungeness	10% SUS	500	6% SUS
Elwha	10% SUS	1,000	6% SUS
Western JDF	10% SUS	500	6% SUS

[1] natural-origin spawners.
[2] The threshold is escapement of 800 natural and/or 500 hatchery (see Appendix A).
[3] Expected SUS rate will not exceed 7% in 4 out of 5 years (see Appendix A)

The management response to critical status has two principal components:

1. A Critical Exploitation Rate Ceiling (CERC) is established for each management unit (Table 3), imposing an upper limit on SUS impacts when spawning escapement for that unit is projected to fall below its low abundance threshold. The CERCs are defined as total SUS ceiling exploitation rates for most management units. For the Lake Washington, Green, Puyallup, Nisqually, Mid Hood Canal and Skokomish units, the ceiling rates apply only to pre-terminal fisheries. For these units, additional terminal fishery management responses are detailed in the unit profiles (Appendix A). Except for Mid-Hood Canal, they are composite populations in that hatchery production contributes substantially to fisheries and natural spawning

The MFR, which is described in detail in Appendix C for fisheries in Puget Sound and Washington coastal ocean areas, provides for Treaty Indian and non-Indian harvest of the surplus abundance of non-listed chinook, and sockeye, pink, coho, and chum salmon.

The MFR represents the lowest level of fishing mortality on listed chinook that is possible, while still allowing a reasonable harvest of non-listed salmon. Reducing tribal fisheries to those specified in the MFR, while requiring significant sacrifice of fishing opportunity guaranteed by treaty rights, represent the minimum level of fishing that allows some exercise of those rights, and demonstrates their commitment to contribute, with concomitant and essential habitat protection and other recovery actions, to the recovery of Puget Sound chinook salmon to levels that would satisfy their treaty rights.

The co-managers established the CERCs, after policy consideration of the MFR, and examination of FRAM simulations of the recent fisheries regimes that responded to critical status for some management units. Exploitation rates associated with constant mortality in SUS fisheries will change, in part due to variation in the abundance of stocks from British Columbia, the Columbia River, and Puget Sound, and variation in intercepting fishing mortality exerted by fisheries in British Columbia and Alaska. The CERCs reflect this source of variation (i.e. they are, in some cases, higher than the SUS exploitation rates projected in recent years). Furthermore, if significant changes are made to the FRAM that alter the calculation of exploitation rates, these ceilings may be adjusted in consultation with the NMFS.

2. Within the constraint established by the CERCs, southern U.S. fisheries will be limited so that their impact on critical management units does not exceed the levels projected to occur with the 2003 fisheries (see Implementation, below). The CERCs, thus, impose a hard ceiling on SUS exploitation rates, but annual fishing plans are likely to result in impacts that fall below the CERC for some critical units. New fisheries, beyond those planned for 2003, will not be implemented with the intention of increasing impacts on critical units, unless other fisheries are shaped to reduce fishing mortality on those units to an equivalent degree.

4. The Fisheries and Jurisdictions

Puget Sound chinook contribute to fisheries along the coast of British Columbia and Alaska, in addition to those in the coastal waters of Washington and Puget Sound. Their management, therefore, involves the local jurisdictions of the Washington co-managers, and the jurisdictions of the State of Alaska, the Canadian Department of Fisheries and Oceans, the Pacific Salmon Commission, and the Pacific Fisheries Management Council.

4.1 Southeast Alaskan Fisheries

In Southeast Alaska (SEAK) chinook are harvested in commercial, subsistence, personal use, and recreational fisheries throughout Southeast Alaska. Since 1995, the total landed chinook catch has ranged from 217,000 to 339,000 (Table 4). These fisheries are managed by the Alaska Board of Fisheries and the Department of Fish and Game, under oversight of the North Pacific Fisheries Management Council to ensure consistency of fisheries management objectives with the Sustainable Fisheries Act (1996).

Commercial fisheries employ troll, gillnet, and purse seine gear. Commercial trolling accounts for about 68% of the chinook harvest (NMFS 2002). Approximately 6% of the catch of chinook and coho is taken outside of State waters, in the Economic Exclusive Zone (EEZ). The majority of troll catch occurs during the summer season; but ‘winter’ and ‘spring’ troll seasons are also scheduled from October through April. The summer season usually opens on July 1st, targeting chinook, then shifts to a coho-directed fishery in August. Incidental harvest of pink, chum, and sockeye salmon also occurs in the troll fishery. Gillnet and seine fisheries occur within State waters, and target pink, sockeye, and chum salmon, with substantial incidental catch of coho, and relatively low incidental catch of chinook.

Table 4. Chinook salmon harvest, all fisheries combined, in Southeast Alaska, 1998 – 2002 (PSC 2001, PSC 2002).

1998	271,000
1999	251,000
2000	263,300
2001	260,000
2002	442,200

Recreational fishing in Southeast Alaska, in recent years, has comprised more than 500,000 angler days annually. It occurs primarily in June, July, and August. A majority of the effort is associated with non-resident fishers, and is targeted at chinook salmon. Fishing is concentrated in the vicinity of the major populations centers; Ketchikan, Petersburg, Sitka, and Juneau, but it also occurs along the coast of Prince of Wales Island and other remote areas. Fishing in the vicinity of Sitka accounts for 47% of the recreational chinook harvest (Jones and Stokes 1991).

Chinook from the Columbia River, Oregon coast, Washington coast, west coast of Vancouver Island (WCVI), and northern B.C. contribute significantly to harvest in Southeast Alaska (CTC 2003). Few Puget Sound chinook are caught in Alaska, except for Strait of Juan de Fuca stocks, which have significant exploitation rates in Southeast Alaska (up to 30% of the catch of Elwha, and, in some years, over 50% of the catch of Hoko chinook). Also, in some years, between 5%

and 10% of the catch of Stillaguamish chinook has been taken in Southeast Alaska (Chinook TC 1999).

More than 3,000 subsistence and personal use permits were issued in Southeast Alaska in 1996 (NMFS 2002), but only a small proportion of the subsistence harvest of salmon (33,000 in 1996) is made up of chinook.

4.2 Fisheries in British Columbia

In British Columbia, troll fisheries occur on the northern coast and on the WCVI. Conservation concerns over WCVI and Fraser River chinook and coho stocks have constrained these fisheries in recent years. Commercial and test troll fisheries directed at pink salmon in northern areas, and sockeye on the WCVI and the southern Strait of Georgia incur relatively low incidental chinook mortality. Time / area restrictions, and selective gear regulations have been implemented to reduce the harvest of weak chinook and coho stocks.

Net fisheries, including gillnet and purse seine gear, in British Columbia marine inshore waters are primarily directed at sockeye, pink, and chum salmon, but also incur incidental chinook mortality. Conservation measures have limited chinook retention in many areas. Chinook catch in the Northern B.C. and WCVI troll fisheries increased markedly in 2002 (Table 5).

Table 5. Landed chinook harvest in British Columbia inshore marine fisheries in 2001 and 2002 (CDFO 2001, CDFO 2002).

	2001	2002
Northern BC troll	13,100	94,748
WCVI troll	77,000	133,693
Georgia Strait troll	485	369
Northern BC net	22,035	11,041
Central BC net	4,589	4,827
Native North and Central	7,231	5,379
Johnstone Strait net	1,000	1,025
WCVI outside sport	36,000	22,009
QCI & North coast sport	38,500	41,300
Central coast sport	7,736	6,305
JDF, GS, JS sport	57,526	84,426
Total	265,202	404,753

Recreational harvest of chinook in the Queen Charlotte Islands and on the WCVI have been similarly constrained by time / area and size regulations to conserve weak chinook stocks. Nearshore waters along the entire WCVI were closed to salmon fishing in 1999 – 2001 (CDFO 2000; CDFO 2001). Limited recreational fisheries have been implemented in the ‘inside’ waters of the WCVI (e.g. in Nootka Sound, Esperanza Inlet, and Tlupana Inlet). Marine recreational fisheries occur along the Central B.C. coast, Johnstone Strait, Georgia Strait, and the Strait of Juan de Fuca. Sport fisheries in inshore marine areas comprise the largest portion of the chinook harvest in southern B.C.

Fisheries in northern B.C. target local stocks, but chinook from the Columbia River, Washington and Oregon coasts, Georgia Strait, and the WCVI are also caught (CTC 2001). Puget Sound chinook make up a minor portion of the catch, but a significant portion of the mortality of North Sound and Strait of Juan de Fuca spring and summer/fall chinook can occur in these fisheries (see Catch Distribution, below). WCVI fisheries, which target on Columbia River, Puget Sound, and Georgia Strait stocks, have a major impact on all Puget Sound summer/fall stocks, with a lower, but significant impact on springs. Georgia Strait fisheries target on Georgia Strait and Puget Sound chinook, and have heavy impacts on North Sound springs, North Sound summer/falls, and Hood Canal summer/falls, and significant, but lower impacts on all other Puget Sound stocks (Chinook TC 1999).

4.3 Washington Ocean Fisheries

Treaty Indian and non-treaty commercial troll fisheries directed at chinook, coho, and pink salmon, and recreational fisheries directed at chinook and coho salmon are scheduled from May through September, under co-management by the WDFW and Treaty Tribes. The Pacific Fisheries Management Council (PFMC), pursuant to the Sustainable Fisheries Act (1996), oversees annual fishing regimes. Tribal fleets operate within the confines of their usual and accustomed fishing areas. Principles governing the co-management objectives and the allocation of harvest benefits among tribal and non-Indian users, for each river of origin, were developed under *Hoh v Baldrige* (522 F.Supp. 683 (1981)). The declining status of Columbia River origin chinook stocks has been the primary constraint on coastal fisheries, though consideration is also given to attaining allocation objectives for troll, terminal net, and recreational harvest of coastal-origin stocks from the Quillayute, Queets, Quinault, Hoh, and Grays Harbor systems. These fisheries primarily target Columbia River chinook (Chinook Technical Committee 2001). Puget Sound chinook make up a low percentage of the catch, with South Sound and Hood Canal stocks exploited at a slightly higher rate than North Sound and Strait of Juan de Fuca chinook.

The ocean troll fishery (Table 6) has been structured, in recent years, as chinook-directed fishing in May and June, and chinook- and coho-directed fishing from July into mid-September, to enable full utilization of Treaty and non-Treaty chinook and coho quotas. These quotas (i.e. catch ceilings) are developed in a pre-season planning process that considers harvest impacts on all contributing stocks. Time, area, and gear restrictions are implemented to selectively harvest the target species and stock groups. In general, the chinook harvest occurs 10 to 40 miles offshore, whereas the coho fishery occurs within 10 miles off the coast, but annual variations in the distribution of the target species cause this pattern to vary. The majority of the chinook catch has, in recent years, been caught in Areas 3 and 4 (which, during the summer, includes the westernmost areas of the Strait of Juan de Fuca – Areas 4B). In the last five years, troll catch has ranged from 18,000 to 93,000 (Table 6).

Table 6. Commercial troll and recreational landed catch of chinook in Washington Areas 1 – 4, 1998 – 2002 (Simmons et al. 2002).

	Treaty Troll	Non-Treaty troll	Recreational	Total
1998	14,859	5,929	2,187	22,975
1999	27,664	17,456	9,887	55,007
2000	7,770	10,269	8,478	26,517
2001	28,100	21,229	22,974	72,303
2002	39,184	53,819	57,821	150,824

In odd-numbered years, the coastal troll fishery may also target pink salmon, the majority of which originate in the Fraser River. In the last six odd-numbered years, the annual troll harvest of pink salmon has ranged from 1,800 to 48,300.

Recreational fisheries, in Washington Ocean areas, are also conducted under specific quotas for each species, and allocations to each catch area. WDFW conducts creel surveys at each port to estimate catch and keep fishing impacts within the overall quotas. Most of the recreational effort occurs in Areas 1 and 2, adjacent to Ilwaco and Westport. Generally recreational regulations are not species directed, but certain time / area strata have had chinook non-retention imposed, as conservation concerns have increased, and to enable continued opportunity based on more abundant coho stocks. In the last five years, recreational chinook catch in Areas 1 – 4 has ranged from 2,187 to 53,819 (Table 3).

Puget Sound chinook stocks comprise less than 10 percent of coastal troll and sport catch (see below for more detailed discussion of the catch distribution of specific populations). The contribution of Puget Sound stocks is higher in northern areas, along the coast. The exploitation rate of most individual chinook management units in these coastal fisheries is, in most years, less than one percent. However, these exploitation rates vary annually in response to the varying abundance of commingled Columbia River, local coastal, and Canadian chinook stocks.

Amendment 14 to the PFMC Framework Management Plan restricts the direct oversight of conservation to those chinook stocks whose exploitation rate in fisheries under the jurisdiction of the PFMC (i.e., coastal ocean fisheries between the borders of Mexico and British Columbia, including Washington catch areas 1 – 4) have exceeded two percent, in a specified base period. However, the PFMC must also align its harvest objectives with conservation standards required for salmon ESUs, listed under the Endangered Species Act. Additionally, this Plan, along with the Puget Sound Salmon Management Plan, commits the co-managers to explicit consideration of coastal fishery impacts, to ensure that the overall conservation objectives are achieved for all Puget Sound Management Units. This requires accounting all impacts on all management units, even in fisheries where contribution is very low.

4.4 Puget Sound Fisheries

4.4.1 Tribal Ceremonial and Subsistence Fisheries

Indian tribes schedule ceremonial and subsistence chinook fisheries to provide basic nutritional benefits to their members, and to maintain the intrinsic and essential cultural values imbued in traditional fishing practices and spiritual links with the natural resources. The magnitude of ceremonial and subsistence harvest of chinook is small relative to commercial and recreational harvest, particularly where it involves critically depressed stocks.

4.4.2 Commercial Chinook Fisheries

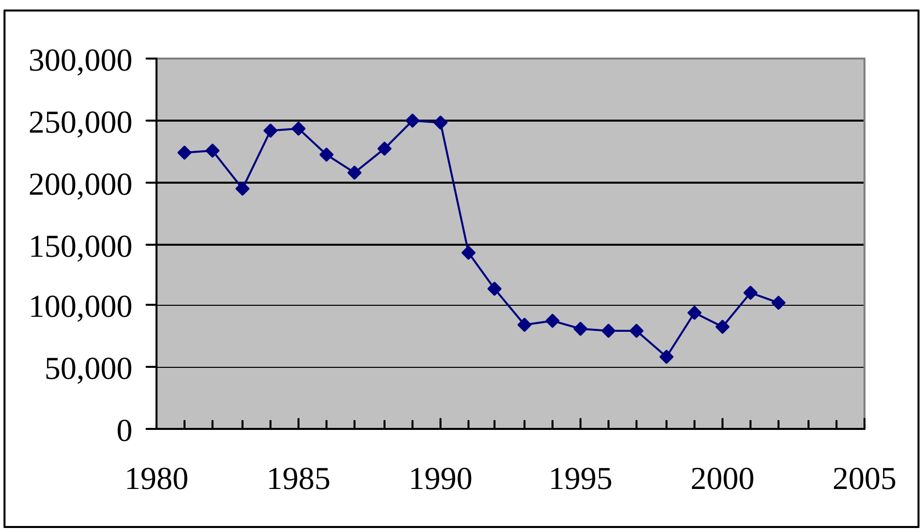
Commercial salmon fisheries in Puget Sound, including the U.S. waters of the Strait of Juan de Fuca, Rosario Strait, Georgia Strait, embayments of Puget Sound, and Hood Canal, are co-managed by the tribes and WDFW under the Puget Sound Salmon Management Plan. Several tribes conduct small-scale commercial troll fisheries directed at chinook salmon in the Strait of Juan de Fuca and Rosario Strait. In the western Strait of Juan de Fuca, most of the effort occurs in winter and early spring, with annual closure from mid-April to mid-June to protect maturing spring chinook. Annual harvest has ranged from 1,000 to 2,000 in the last five years.

Commercial net fisheries, using set and drift gill nets, purse or roundhaul seines, beach seines, and reef nets are conducted throughout Puget Sound, and in the lower reaches of larger rivers. These fisheries are regulated, by WDFW (non-treaty fleets) and by individual tribes, with time/area and gear restrictions. In each catch area, harvest is focused on the target species or stock according to its migration timing through that area. Management periods are defined as that interval encompassing the central 80% of the migration timing of the species, in each management area. Because the migration timings of different species overlap, the actual fishing schedules may be constrained during the early and late portion of the management period to reduce impacts on non-target species. Incidental harvest of chinook also occurs in net fisheries directed at sockeye, pink, and coho salmon.

Due to current conservation concerns, chinook-directed commercial fisheries are of limited scope and are mostly directed at abundant hatchery production in terminal areas; Bellingham /Samish Bay and the Nooksack River, Tulalip Bay, Elliot Bay and the Duwamish River, Lake Washington, the Puyallup River, the Nisqually River, Budd Inlet, Chambers Bay, Sinclair Inlet, southern Hood Canal and the Skokomish River. Purse or roundhaul seine vessels operate in Bellingham Bay and Tulalip Bay, although these are primarily gillnet fisheries. A small-scale, onshore, marine set gillnet fishery is conducted in the Strait of Juan de Fuca and on the coast immediately south of Cape Flattery. Small scale gillnet research or evaluation fisheries are also used in-season to acquire management and research data in the Skagit River, Elliot Bay, Puyallup River, and Nisqually River. Typically, these involve two or three vessels making a prescribed number of sets at specific locations, one day per week, during the run’s passage.

Total commercial net and troll harvest of chinook has fallen from levels in excess of 200,000 in the 1980s to an average of 89,500 for the period 1998 – 2002. (Figure 1).

Figure 1. Commercial net and troll catch of chinook in Puget Sound, 1980 – 2002 (TFT database).



4.4.3 Commercial Sockeye, Pink, Coho, and Chum Fisheries

Net fisheries directed at Fraser River sockeye are conducted annually, and at Fraser River pink salmon in odd-numbered years, in the Strait of Juan de Fuca, Georgia Strait, and the Straits and passages between them (i.e., catch areas 7 and 7A). Nine tribes and the WDFW issue regulations for these fisheries, as participants in the Fraser River Panel, under Pacific Salmon Treaty Annexes. Annual management plans include sharing and allocation provisions, but fishing schedules are developed based on in-season assessment of the abundance of early, early summer, summer, and late-run sockeye stocks and pink salmon.

Sockeye harvest has exceeded 2 million in the last ten years, but the fishery has been constrained in recent years due to lower survival and pre-spawning mortality of sockeye, so harvest has ranged from 20,000 to 512,500 since 1998 (Table 7). In the last six seasons (1991 – 2001) the fishery for Fraser River pink salmon in harvested up to 1.74 million fish (Table 7). Most of the pink salmon harvest is taken by purse seine gear. Specific regulations to reduce incidental chinook mortality, including requiring release of all live chinook from non-treaty purse seine fishery hauls, have reduced incidental contribution to less than 1% of the total catch.

Table 7. Fraser sockeye and pink salmon harvest, and incidental chinook catch, in Puget Sound, 1996 – 2002. (TFT database, 2002 data are preliminary).

		1996	1997	1998	1999	2000	2001	2002
Strait of	sockeye	30,314	12,509	26,728	20,230	41,974	34,973	45,600
Juan de Fuca	pink	6	3,017	35	4,105	91	7,064	173
	chinook	606	492	264	589	640	931	1,074
Rosario and	sockeye	243,918	1,268,078	499,939	22	428,661	206,435	389,921
Georgia Strait	pink	1	1,740,356	807	10	253	466,494	21
	chinook	3,934	29,215	3,804	3	1091	970	2,229

Commercial fisheries directed at Cedar River sockeye stocks occur in Elliot Bay, the Ship Canal, and Lake Washington, and much smaller scale fisheries on Baker river sockeye may occur in the Skagit River. The Cedar River stock does not achieve harvestable abundance consistently, but significant fisheries occurred in 1996, 2000, and 2002. However, these fisheries exert very low incidental chinook mortality.

Commercial fisheries directed at Puget Sound-origin pink salmon occur in terminal marine areas and freshwater in Bellingham Bay and the Nooksack River, Skagit Bay and Skagit River, and Possession Sound / Port Gardner (Snohomish River system). In the last six seasons, catch in the Nooksack system has ranged up to 17,500; in the Skagit system catch has ranged up to 525,000, and in the Snohomish system catch has ranged up to 86,100 (Table 8). Terminal-area pink fisheries involve significant incidental catch of chinook.

Table 8. Commercial net fishery harvest of pink salmon from the Nooksack, Skagit, and Snohomish river systems, 1991 – 2001. 2001 data are preliminary. (TFT database).

	Bellingham Bay & Nooksack River	Skagit Bay & Skagit River	Possession Sound & Port Gardner
1991	17,447	133,672	46,039
1993	1,335	143,880	9,648
1995	7,339	524,810	48,006
1997	1,196	46,169	34,537
1999	2,484	32,339	13,055
2001	12,280	198,534	86,097

Commercial fisheries directed at coho salmon, also occur throughout Puget Sound and in some rivers. Coho are also caught incidentally in fisheries directed at chinook, sockeye, pink, and chum salmon. In the last five years total landed coho catch has ranged from 107,646 to 315,124, with over 40% of the catch taken in central and south Puget Sound, and 20% taken in each of the Nooksack – Samish, and Snohomish regions (Table 9). Catch in every region has increased since 2000 relative to the late-1990s, but is still below the levels of the early 1990s, when the total harvest exceeded one million coho.

Table 9. Landed coho harvest for Puget Sound net fisheries, 1998 - 2002. Regional totals include freshwater catch (TFT database).

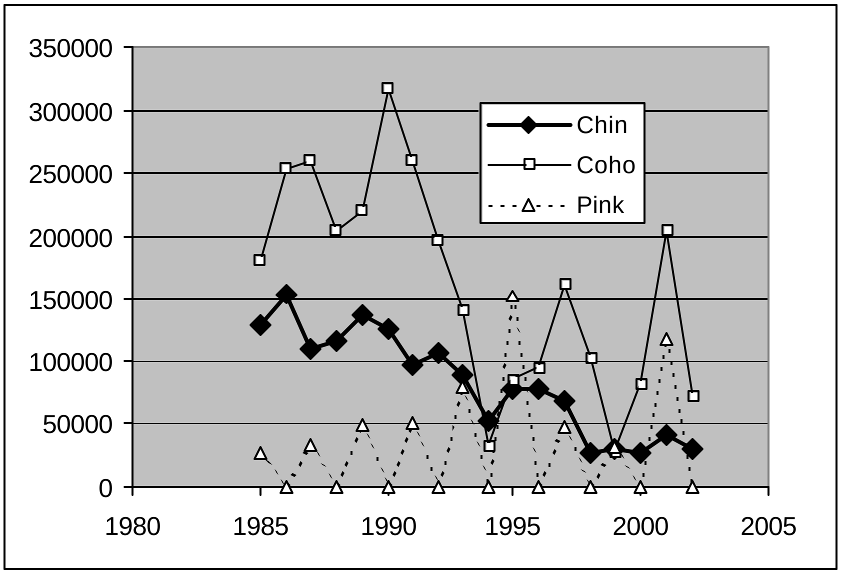
	Strait of Juan de Fuca	Georgia & Rosario Strait	Nooksack Samish	Skagit	Stillaguamish Snohomish	So Puget Sound	Hood Canal	Total
1998	8,083	1,980	22,892	10,359	24,743	65,617	21,974	155,648
1999	5,586	1	50,175	7,411	18,439	21,189	4,845	107,646
2000	4,338	1,501	67,587	11,151	86,328	186,397	20,860	378,162
2001	15,521	721	76,232	15,948	60,863	137,327	8,512	315,124
2002	9,458	3,638	50,863	7,688	48,578	107,236	7,547	235,008

4.4.4 Recreational Fisheries

Recreational salmon fisheries in Puget Sound occur in marine (Areas 5 – 13) and freshwater areas, under regulations promulgated by the Washington Department of Fish and Wildlife. In marine areas, the principal target species are chinook and coho salmon. Since the mid-1980s the total annual marine harvest of chinook has steadily declined from levels in excess of 100,000 in the late 1980s to an average of 31,150 in the last five years (Figure 2). Marine-area coho harvest has varied widely in the last five years, averaging 98,250. Odd-year pink salmon harvest has also varied widely; it exceeded 117,000 in 2001.

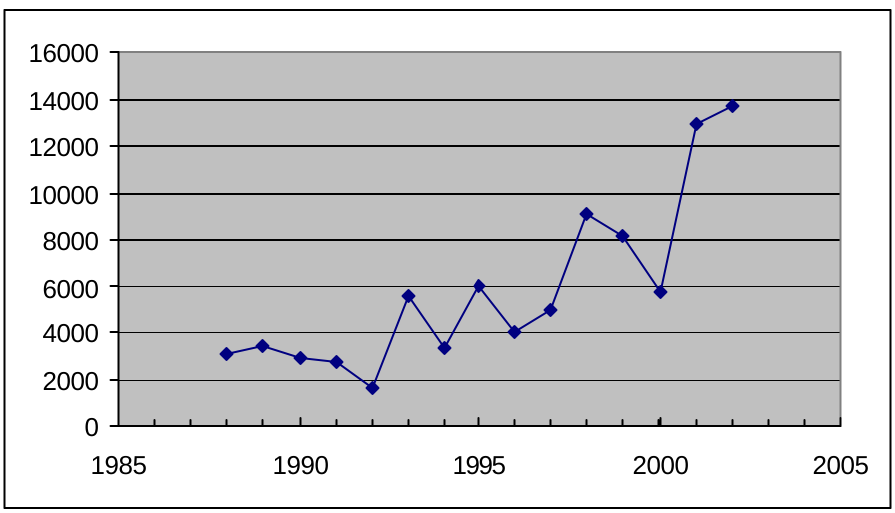
Recreational fisheries that target immature chinook ('blackmouth') occur during the summer months (July – September), and continue through the fall and winter months, and into the early spring, primarily in central Puget Sound. Recreational chinook catch has been increasingly constrained to avoid overharvest of weak Puget Sound populations. Recreational fisheries are managed under the same harvest objectives for chinook and coho salmon that apply to commercial fisheries. WDFW has exercised their policy prerogative in allocating, in recent years, more of the non-Treaty fishing opportunity to the recreational sector.

Figure 2. Recreational salmon catch in Puget Sound marine areas, 1985 – 2002 (WDFW CRC estimates; 2002 data are preliminary).



Perhaps in response to increasingly constrained bag limits and seasons in marine areas, and the increasing abundance of some stocks, recreational harvest of chinook in freshwater areas of Puget Sound has shown an increasing trend since the early 1990s (Figure 3).

Figure 3. Recreational chinook harvest in Puget Sound freshwater areas 1988 - 2002 (WDFW Catch Record Card estimates; excludes jacks).



4.4.5 Non-Landed Fisheries Mortality

In all fisheries, each type of commercial and recreational gear also exerts 'non-landed' mortality on chinook. The rates currently used to assess non-landed mortality are shown below (Table 10). A more detailed description of the basis for these rates and their application is included in Appendix B.

Hook-and-line fisheries are regulated by size limits, recreational bag limits, and non-retention periods. A proportion of all fish not kept will die from hooking trauma. A large body of relevant literature expresses a very broad range of hooking mortality rates. Rates are assumed to be higher for commercial troll than recreational gear, and higher for smaller fish. As bag limits on recreational fisheries have decreased, the proportion of non-landed mortality has risen accordingly. The Washington co-managers and the PFMC have periodically reviewed the literature, and adjusted the non-landed mortality rates associated with hook-and-line fisheries, so that fisheries simulation models used in management planning express the best available science. For hook and line gear, the release mortality (or "shaker mortality") rate refers to the percentage of fish which are brought to the boat and released, because they are below the legal size limit, or a species for which regulations preclude retention. Drop-off mortality rate is calculated as a proportion of the landed catch, but refers to fish that are hooked but escape before being brought to the boat.

The various types of net gear also exert non-landed mortality. Studies to quantify rates are difficult to design and implement, so few reference data are available. Though survival of gillnet entanglement is not well understood, a small proportion, currently assumed to be 3% of landed catch in pre-terminal areas, 2% in terminal fisheries, drops out of the mesh before the gear is retrieved. Marine mammal predation adds a significant additional loss in many areas of Puget Sound, but their effect varies from year to year, and among areas. The assumed rates do not express this variation in mammal predation, and the few available studies that exist are specific to certain areas (Young 1989). Purse seine gear, for the non-treaty fleet, has been modified, by regulation, to reduce the catch of immature chinook by incorporating a strip of wide-mesh net at the surface of the bunt. Nonetheless, small chinook are caught by seine gear, and are assumed more likely to be killed. Non-treaty seine fishers have been required to release all chinook in all areas of Puget Sound in recent years, in order to allocate mortality to other fisheries. Mortality rates vary due to a number of factors, but studies have shown that two-thirds to half of chinook survive seine capture, particularly if the fish are sorted immediately or allowed to recover in a holding tank before release. Because total catch is typically small for beach seine and reef net gear, chinook may be released without harm. Research continues into net gear that reduces release mortality, with promising results from recent tests of tangle nets (Vander Haegen et al. 2003; Vander Haegen et al. 2002(a); Vander Haegen et al. 2002(b); Vander Haegen et al. 2001). In any case, non-landed mortality is accounted by managers, according to the best available information, to quantify the mortality associated with harvest.

Table 10 . Chinook incidental mortality rates applied to commercial and recreational fisheries in Washington.

Fishery	Release Mortality	Drop-off, Drop-out, etc
Ocean Recreational	14%	5%
Ocean troll - barbless hooks	26%	5%
- barbed hooks	30%	5%
Puget Sound recreational	> 22" - 10%	5%
	< 22" - 20%	5%
Gillnet		terminal areas - 2% pre-terminal areas - 3%
Skagit Bay	52.4%	
Purse Seine	immature fish- 45%	0%
	mature fish - 33%	0%
Beach Seine		
Skagit Bay pink fishery	50%	0%
Reef Net	0%	0%

4.5 Regulatory Jurisdictions Affecting Washington Fisheries

Fisheries planning and regulation by the Washington co-managers are coordinated with other jurisdictions, in consideration of the effects of Washington fisheries on Columbia River and Canadian chinook stocks. Pursuant to *U.S. v Washington* (384 F. Supp. 312), the Puget Sound Salmon Management Plan (1985) provides fundamental principles and objectives for co-management of salmon fisheries.

The Pacific Salmon Treaty, originally signed in 1984, commits the co-managers to equitable cross-border sharing of the harvest and conservation of U.S. and Canadian stocks. The Chinook Chapter of the Treaty, which is implemented by the Pacific Salmon Commission, establishes ceilings on chinook exploitation rates in southern U.S. fisheries The thrust of the original Treaty, and subsequently negotiated agreements for chinook, was to constrain harvest on both sides of the border in order to rebuild depressed stocks.

The PFMC is responsible for setting harvest levels for coastal salmon fisheries in Washington, Oregon, and California. The PFMC adopts the management objectives of the relevant local authority, provided they meet the standards of the Sustainable Fisheries Act. The Endangered Species Act has introduced a more conservative standard for coastal fisheries, when they significantly impact listed stocks.

4.5.1 Puget Sound Salmon Management Plan (U.S. v. Washington)

The PSSMP remains the guiding framework for jointly agreed management objectives, allocation of harvest, information exchange among the co-managers, and processes for negotiating annual harvest regimes. At its inception, the Plan implemented the court order to provide equal access to salmon harvest opportunity to Indian tribes, but its enduring principle is to “promote the stability and vitality of treaty and non-treaty fisheries of Puget Sound …. and improve the technical basis for …management.” It defined management units (see Chapter III), and regions of origin, as the basis for harvest objectives and allocation, and established maximum sustainable harvest (MSH) and escapement as general objectives for all units. The PSSMP also envisioned the adaptive management process that motivated this Plan. Improved technical understanding of the productivity of populations, and assessment of the actual performance of management regimes in relation to management objectives and the status of stocks, would result in continuing modification of harvest objectives.

4.5.2 Pacific Salmon Treaty

In 1999, negotiations between the U.S. and Canada resulted in a new, comprehensive chinook agreement, which replaced the previous fixed-ceiling regime with a new approach based on the annual abundance of stocks. It includes increased specificity on the management of all fisheries affecting chinook, and seeks to address the conservation requirements of a larger number of depressed stocks, including some that are now listed under the ESA.

The new agreement establishes exploitation rate guidelines or quotas for fisheries subject to the PST based on the forecast abundance of key chinook stocks. This regime will be in effect for the 1999 through 2008 period. Fisheries are classified as aggregate abundance-based management regimes (AABM) or individual stock-based management regimes (ISBM). As provided in the new chinook chapter of the agreement: “an AABM fishery is an abundance-based regime that constrains catch or total adult equivalent mortality to a numerical limit computed from either a pre-season forecast or an in-season estimate of abundance, and the application of a desired harvest rate index expressed as a proportion of the 1979-1982 base period.” (PSC 2000).

Three fishery complexes are designated for management as AABM fisheries: 1) the SEAK sport, net and troll fisheries; 2) the Northern British Columbia troll (statistical areas 1-5) and the Queen Charlotte Islands sport (statistical areas 1 - 2); and 3) the WCVI troll (statistical areas 21,23-27, and 121-127) and sport, for specified areas and time periods. The estimated abundance index each year is computed by a formula specified in the agreement for each AABM fishery. Table 1 of the chinook chapter of the new Annex IV specifies the target catch levels for each AABM fishery as a function of that estimated abundance index.

All chinook fisheries subject to the Treaty that are not AABM fisheries are classified as ISBM fisheries, including freshwater chinook fisheries. As provided in the new agreement, “an ISBM fishery is an abundance-based regime that constrains to a numerical limit the total catch or total adult equivalent mortality rate within the fisheries of a jurisdiction for a naturally spawning chinook stock or stock group.” For these fisheries the agreement specifies that Canada and the U.S. shall reduce the total adult equivalent mortality rate by 36.5% and 40% respectively, relative to the 1979-1982 base period, for a specified list of indicator stocks. In Puget Sound these include Nooksack early, Skagit summer/fall and spring, Stillaguamish, Snohomish, Lake Washington, and Green stocks.

If such reductions do not result in the biologically based escapement objectives for a specified list of natural-origin stocks, ISBM fishery managers must implement further reductions across their fisheries as necessary to meet those objectives or as necessary to equal, at least, the average of those reductions that occurred during 1991-1996. Although the specified ISBM objectives must be achieved to comply with the agreement, the affected managers may choose to apply more constraints to their respective fisheries than are specifically mandated by the agreement. The annual distribution of allowable impacts is left to each country’s domestic management processes.

4.5.3 Pacific Fisheries Management Council

The Pacific Fisheries Management Council (PFMC) provides recommendations to the Secretary of Commerce regarding management regulations and sets annual harvest levels for salmon and groundfish fisheries in the coastal marine waters of Washington, Oregon, and California, within the 200-mile EEZ of the United States. The Council was created by the Magnuson Fishery Management and Conservation Act in 1977, and re-authorized by Congress' passage of the Sustainable Fisheries Act in 1996. The Council coordinates and oversees the ocean fishery management objectives among the three state jurisdictions by mandating regulations that prevent overfishing and maintain sustainable harvest. The Council's function is to assure that conservation objectives are achieved for all chinook and coho stocks, and that harvest is equitably shared among the various user groups. The State of Washington asserts jurisdiction regarding regulation of fisheries inside the EEZ (i.e., within three miles of the coast), by adopting the same catch quotas that are approved annually by the PFMC.

The fundamental principles and implementation of the conservation standards are outlined in the Framework Management Plan (FMP). The Council has adopted amendments to the FMP to address specific conservation and management issues. The FMP includes specific management goals and objectives for salmon stocks, usually stated as escapement goals or exploitation or harvest rates. These objectives are based on the fundamental principle of providing optimum yield, which was re-defined to mean 'maximum sustainable yield, as reduced by relevant economic, social, or ecological factors" (PFMC 1999).

Amendment 14 to the Pacific Coast Salmon Plan included conservation objectives, expressed as the number of natural, adult spawners, for chinook stocks from Puget Sound and the Strait of Juan de Fuca. These objectives could be revised without FMP amendment according to procedures in the PSSMP. Stocks listed under the ESA are treated as the third exception to the application of overfishing criteria in the SFA. The NMFS conducts a consultation to determine whether the impact of coastal fisheries pose jeopardy to listed species. The PFMC considers the requirements of the ESA are sufficient to also achieve the intent of the SFA's overfishing provision. This implies that it is insufficient to just achieve current MSH escapement; the objective to achieve recovery to MSH escapement under restored habitat conditions. Meeting the jeopardy standard may be sufficient to stabilize the population until freshwater habitat is restored (Amendment 14 Section 3.2.4.3).

4.6 Distribution of Fishing Mortality

A significant portion of the fishing mortality on many Puget Sound chinook stocks occurs outside the jurisdiction of this plan, in Canadian and, in some cases, Southeast Alaskan fisheries (Table 11), based on recoveries of coded-wire tagged indicator stocks. Of the Puget Sound indicator stocks, more than half of the total mortality of Stillaguamish summer, Hoko fall, Nooksack early, and Skagit spring chinook occurs in Alaska and Canada. Washington ocean troll fisheries generally account for a small proportion of the mortality of Puget Sound chinook, but their impact exceeds 5 percent of total fisheries-related mortality for Skokomish and South Puget Sound fall indicator stocks. Puget Sound net and Washington sport fisheries account for the largest proportion of fishing mortality for most Puget Sound stocks

Table 11. Distribution of harvest for Puget Sound chinook indicator stocks, expressed as an average (1996-2000) proportion of total, annual, adult equivalent fishing exploitation rate (CTC 2003).

	Alaska	B.C.	Washington troll	Puget Sound Net	Washington Sport
Samish Fall	2.3%	43.0%	1.8%	40.2%	12.7%
Stillaguamish Sum	17.8%	50.3%	0.3%	2.6%	29.1%
South Puget Snd Fall	2.0%	29.6%	6.0%	21.7%	40.7%
Nisqually Fall	0.5%	14.5%	2.6%	44.9%	37.6%
Skokomish Fall	1.7%	37.4%	9.0%	7.2%	44.7%
Hoko Fall	74.2%	25.3%	0.0%	0.6%	0.0%
Nooksack Spring	1.6%	75.7%	1.5%	3.0%	18.3%
Skagit Spring	1.0%	51.4%	1.2%	7.1%	39.2%
White River Spring	0.0%	4.5%	0.6%	3.5%	91.4%

4.7 Trends in Exploitation Rates

FRAM 'validation' runs, which incorporate catch and stock abundance from post-season assessment, are available for management years 1983 – 2000, and provide an index of the trend in the total exploitation rate of Puget Sound chinook (A. Rankis, NWIFC, pers comm. October 27, 2003). For these models, post-season abundances, in terms of total recruitment, are estimated from the observed terminal run sizes by using pre-terminal expansion factors estimated either from CWT preterminal exploitation rates, or from fishing effort scale factors

For Category 1 MUs, fisheries management has reduced exploitation rates steadily since the 1980s. Total exploitation rates on Skagit, Stillaguamish, and Snohomish units have declined 56 to 64 percent from the 1983 - 1987 average to the 1998 – 2000 average (Figure 4). Total exploitation rates on spring chinook have also declined. The average rate on Nooksack early chinook has declined 63 percent, on White River spring chinook 51 percent, and on Skagit spring chinook 57 percent. (Fig 5). (A. Rankis, NWIFC pers. comm. October 27, 2003)

Figure 4. Trend in total exploitation rate for Skagit, Stillaguamish, and Snohomish summer/fall chinook management units (post season FRAM estimates).

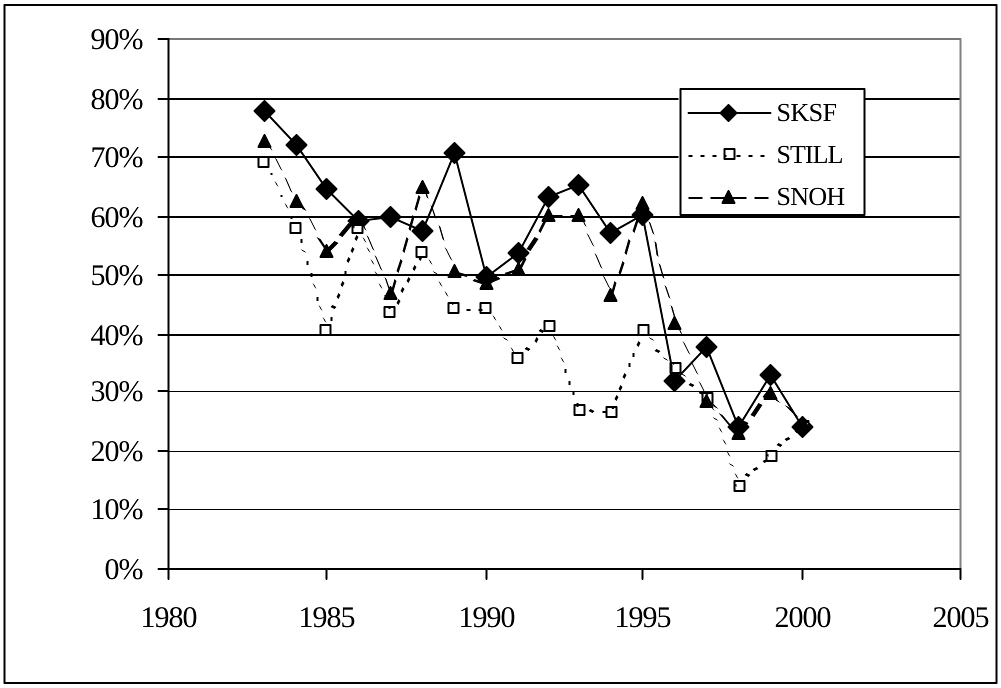
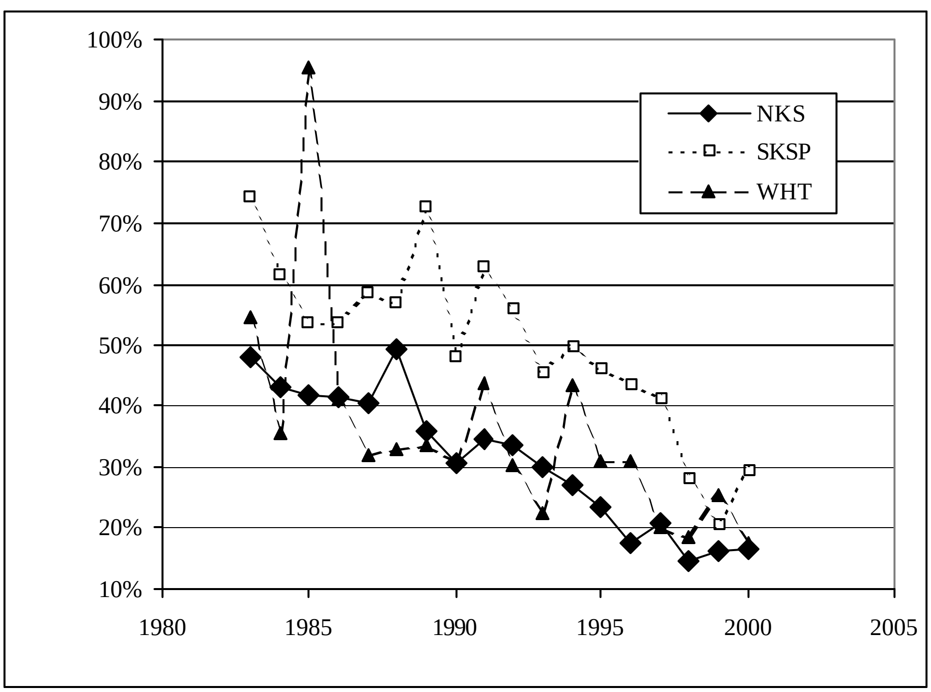


Figure 5. Trend in total exploitation rate for Nooksack, Skagit, and White spring chinook management units (post-season FRAM estimates).



5. Implementation

5.1 Management Intent

The co-managers' primary intent is to control impacts on weak, listed chinook populations, in order to avoid impeding their rebuilding, while providing sufficient opportunity for the harvest of other species, abundant returns of hatchery-origin chinook, and available surpluses from stronger natural chinook stocks. For the duration of this Plan, directed fisheries that target listed chinook populations are precluded, unless a harvestable surplus exists, and except for very small-scale tribal ceremonial and subsistence harvest, and research-related fisheries in a few areas.

For the purposes of this Plan, 'directed' fisheries are defined as those in which more than 50 percent of the total fishery-related mortality is made up of listed, Puget Sound-origin chinook. Total mortality includes all landed and non-landed mortality (see Appendix B).

Landed and non-landed incidental mortality of listed chinook will occur in fisheries directed at non-listed hatchery-origin chinook and other salmon species, but will be strictly constrained by harvest limits that are established expressly to conserve listed chinook.

5.2 Rules for Allowing Fisheries

The annual management strategy, for any given chinook management unit, shall depend on whether a harvestable surplus is forecast. This Plan prohibits targeted harvest on listed populations of Puget Sound chinook, unless they have harvestable surplus. In other words, if a management unit does not have a harvestable surplus, then harvest-related mortality will be constrained to incidental impacts. Directed and incidental fishery impacts are constrained by stated harvest rate ceilings or escapement goals for each management unit. The following rules define how and where fisheries can operate:

- Fisheries may be conducted where there is reasonable expectation that more than 50 percent of the resulting fishery-related mortality will accrue to management units and species with harvestable surpluses, as defined in Chapter 3.

- Within this constraint, the intent is to limit harvest of listed chinook populations or management units that lack harvestable surplus, not to develop a fishing regime that exerts the highest possible impact that does not violate specified ceiling exploitation rates or escapement goals.

- Incidental harvest of weak stocks will not be eliminated, but to avoid increasing the risk of extinction of weak stocks, harvest impacts will be reduced to the minimal level that still enables fishing opportunity on non-listed chinook and other species, when such harvest is appropriate.

- Exceptions may be provided for test fisheries that are necessary for research, and limited tribal ceremonial and subsistence fisheries.

Where it is not possible to effectively target productive natural stocks or hatchery production, without a majority of the fishery impacts accruing to runs without a harvestable surplus, use of the above rules will likely necessitate foregoing the harvest of much of the surplus from those more productive management units.

5.3 Rules That Control Harvest Levels

The co-managers' will use the following guidelines when assessing the appropriate levels of harvest for proposed annual fishing regimes:

- The annual fishing regime will be devised to meet the conservation objectives of the weakest, least productive management unit or component population. Because these units commingle to some extent with more productive units, even in terminal fishing areas, meeting the needs of these units may require reduction of the exploitation on stronger units to a significantly lower level than the level that would only meet the conservation needs of the stronger units.

- A management unit shall be considered to have a harvestable surplus if, after accounting for expected Alaskan and Canadian catches, and incidental, test, and tribal ceremonial and subsistence catches in southern U.S. fisheries, an MU is expected to have a spawning escapement greater than its upper management threshold [1] (see Section III), and its projected ER is less than its RER ceiling. In that case, additional fisheries (including directed fisheries) may be implemented until the exploitation rate ceiling is met, consistent with the Rules for Allowing Fisheries (above), or its expected escapement equals the upper management threshold. In this case, impacts may *not* be limited to incidental harvest mortality. The array of fisheries that may harvest the surplus can be widened, to include terminal-area, directed fisheries.

- Implementation of SUS fisheries targeting harvestable surplus for any management unit will be initiated conservatively. Consistent forecasts of high abundance, substantially above the upper management threshold, and preferably corroborated by post-season assessment, would be necessary to initiate such fisheries. This condition is not expected to be met for any Puget Sound management unit within the duration of this plan.

- If a MU does not have harvestable surplus, then, consistent with the rules for allowing fisheries (above), only incidental, test, and tribal ceremonial and subsistence harvests of that MU will be allowed in Washington areas.

- The projected exploitation rate for management units with no harvestable surplus will not be allowed to exceed their rebuilding exploitation rate ceiling (RER). In the event that the projected ER exceeds the ceiling RER, the incidental, test, and subsistence harvests must be further reduced until the ceiling RER is not exceeded (except as noted below).

- The annual fishing regime must meet the guidelines established by the Pacific Salmon Treaty chinook agreement, such that the non-ceiling fishery index will not exceed the Treaty-mandated ceiling (see Section IV, Pacific Salmon Treaty). If the ISBM index is projected to be exceeded, U.S. fisheries must be further reduced until the mandated ceiling is achieved.

[1] For complex management units, meeting the unit upper threshold may not meet the upper thresholds for all component populations.

- After accounting for anticipated Alaskan and Canadian interceptions, test fisheries, ceremonial and subsistence harvest, and incidental mortality in southern U.S. fisheries, if the spawning escapement for any management unit is expected to be lower than its low abundance threshold, Washington fisheries will be further shaped until either the escapement for the unit is projected to exceed its low abundance threshold, or its projected exploitation rate does not exceed the CERC (see section 5.5, below).

- The comanagers may implement additional fisheries conservation measures, where analysis demonstrates they will contribute significantly to recovery of a management unit, in concert with other habitat and enhancement measures.

5.4 Steps for Application to Annual Fisheries Planning

Annual planning of Puget Sound fisheries proceeds concurrently with that of coastal fisheries, from February through early-April each year, in the Pacific Fishery Management Council and North of Cape Falcon forums. These offer the public, particularly commercial and recreational fishing interest groups, access to salmon status information and opportunity to interact with the co-managers in developing annual fishing regimes. Conservation concerns for any management unit are identified early in the process. The steps in the planning process are:

Abundance forecasts are developed for Puget Sound, Washington coastal, and Columbia River chinook management units in advance of the management planning process. Forecast methods are detailed in documents available from WDFW and tribal management agencies. Preliminary abundance forecasts for Canadian chinook stocks, and expected catch ceilings in Alaska and British Columbia, are obtained through the Pacific Salmon Commission or directly from Canada Department of Fisheries and Oceans.

The Pacific Fishery Management Council's annual planning process begins in March by establishing a range of allowable catch ('options') for each coastal fishery. For Washington fisheries, this involves recreational and commercial troll chinook catch quotas for Areas 1 – 4 (including Area 4B in the western Strait of Juan de Fuca).

An initial regime for Puget Sound fishing is evaluated. Recreational fisheries are initially set at levels similar to the previous year's regime. Incidental chinook harvest in pre-terminal net fisheries is projected from recent-year catch data, and the anticipated scope of fisheries for other species in the current year. Terminal area net fisheries in chinook management periods are scaled to harvest surplus production and achieve natural and / or hatchery escapement objectives. The fishery regimes for pre-terminal and terminal net fisheries directed at other salmon species are initially set to meet management objectives for those species.

The FRAM is configured to simulate this initial regulation set for all Washington fisheries, based on forecast abundance of all contributing chinook management units. Spawning escapement for each population, and total and SUS exploitation rates, projected by this model run, are then examined for compliance with management objectives for each Puget Sound chinook management unit, and their component populations.

The initial model runs are used to reveal the scope and magnitude of conservation concerns for any management units in critical status (i.e. where escapement falls short of the low abundance thresholds), and a more general perspective on the achievement of management objectives for all other management units. In accordance with the preceding rules that control harvest levels, regulations governing directed and incidental chinook harvest impacts are adjusted, through technical assessment and negotiation among the co-managers, in order to arrive at a fishery regime that addresses the conservation concerns for weak stocks, ensures that exploitation rate ceilings are not exceeded and / or escapement objectives are achieved for all other units, while achieving the annual harvest objectives of the co-managers.

5.5 Response to Critical Status

When initial FRAM modeling indicates that Puget Sound Chinook units are in critical status (i.e., projected escapement their low abundance thresholds):

1. The pre-season 2003 SUS fishing regime will be modeled, with current forecast abundance, to determine an SUS ER for each critical stock.

2. The objective of pre-season planning will be to achieve an SUS ER less than or equal to that rate (from step 1), provided that rate is below the CERC.

3. If the 2003 fisheries-based rate exceeds the CERC for any critical management unit, the CERC will be the planning objective.

However, the co-managers may, by mutual consent, set the annual management objective for any critical unit between the 2003 fisheries-based rate and the CERC. Under no circumstances will the CERC be exceeded.

Response to Expanding Northern Fisheries

In 2002 and 2003, chinook harvest in some coastal fisheries in British Columbia increased substantially, indicating that those fisheries may reach the limits imposed by Annex IV, Chapter 3 (1999) of the Pacific Salmon Treaty, within the duration of this harvest plan. Increasing Canadian fishery impacts on Puget Sound chinook, in combination with recent SUS fishing regimes, may result in total fisheries impacts exceeding the rebuilding exploitation rates (RER) for one or more of those Puget Sound chinook management units that have total RERs established in this plan.

During preseason planning, if the total exploitation rate for a management unit is projected to exceed the RER established by this Plan (Table 3), the co-managers will constrain their fisheries such that either the RER is not exceeded, or the SUS exploitation rate is less than or equal to the CERC. Modeling exercises have demonstrated potential for this to occur for several Puget Sound units that are unlikely to fall into critical status in the duration of this plan. The CERC, in this circumstance, would constrain SUS fisheries to the same degree as if that unit were in critical status. While this measure imposes a further conservation burden on Washington fisheries, pursuant to the underlying rationale for the MFR, it maintains access to the harvestable surplus of non-listed chinook, and other species

Because of annual variability in abundance among the various populations, there is no single fishing regime that can be implemented from one year to the next to achieve the management objectives for all Puget Sound chinook units. The co-managers have, at their disposal, a range of management tools, including gear restrictions, time / area closures, catch or retention limits, and complete closures of specific fisheries. Combinations of these actions will be implemented in any given year, as necessary, to insure that management objectives are achieved.

Discretionary Conservation Measures

The co-managers may, by mutual agreement, implement further conservation constraint on SUS fisheries, in response to critical status of any management unit, or in response to declining status or heightened uncertainty about status of any management unit, or to achieve allocation objectives. In doing so, they will consider the most recent information regarding the status and productivity of the management unit or population, and past performance in achieving its management objectives. The conservation effect of such measures may not always be quantifiable by the FRAM, but, based on the best available information on the distribution of stocks, will be judged to have beneficial effect

5.7 Compliance with Pacific Salmon Treaty Chinook Agreements

The proposed regime will be examined for compliance with PST chinook agreements, and further adjustments implemented as necessary to achieve compliance.

In 1999, the parties to the Pacific Salmon Treaty agreed to a new abundance-based chinook management regime for fisheries in the United States and Canada. Southern U.S. fisheries are to be conducted as individual stock-based management (ISBM) fisheries keyed to specific stock groups. With respect to Puget Sound chinook, this agreement refers to the abundance status (i.e. spawning escapement) of certain indicator stock groups with respect to their identified escapement goals[2]. The summer/fall indicator group includes the Hoko, Skagit, Stillaguamish, Snohomish, Lake Washington, and Green units; the spring indicator group includes Skagit spring and Nooksack early units. Stepped reductions in ISBM fisheries will be imposed when two or more of these indicator units are projected not to meet their escapement objectives. These reductions will comply with the pass through provisions and general obligations for individual stock-based management regimes (ISBM) pursuant to the chinook chapter within the US/Canada Pacific Salmon Treaty.

Escapement projected by the FRAM, at the conclusion of pre-season planning, will be compared to PST objectives. According to the PST agreement: "the United State shall reduce by 40%, the total adult equivalent mortality rate, relative to the 1979-82 base period, in the respective ISBM fisheries that affect those stocks." The reduction shall be referred to as the "general obligation".

For those stock groups for which the general obligation is insufficient to meet the agreed escapement objectives, the jurisdiction within which the stock group originates shall implement additional reductions:

i) reductions as necessary to meet the agreed escapement objectives; or

ii) which taken together with the general obligation, are at least equivalent to the average of those reductions that occurred for the stock group during the years 1991-96.

[2] Escapement goals for the Puget Sound indicator stocks, equivalent to the upper management thresholds stated in this plan, have been proposed to the Joint Chinook Technical Committee of the Pacific Salmon Commission for incorporation into the chinook agreement.

The Chinook Technical Committee defined the non-ceiling fishery index (CTC 1996). The PST defers to any more restrictive limit mandated by the Puget Sound chinook management plan, or otherwise implemented by the co-managers.

5.8 Regulation Implementation

Individual tribes promulgate and enforce regulations for fisheries in their respective 'usual and accustomed' areas, and WDFW promulgates and enforces non-Indian fishery regulations, consistent with the principles and procedures set forth in the PSSMP. All fisheries shall be regulated to achieve conservation and sharing objectives based on four fundamental elements: (1) acceptably accurate determinations of the appropriate exploitation rate, harvest rate, or numbers of fish available for harvest; (2) the ability to evaluate the effects of specific fishing regulations; (3) a means to monitor fishing activity in a sufficient, timely and accurate fashion; and (4) effective regulation of fisheries, and enforcement, to meet objectives for spawning escapement, harvest sharing, and fishery impacts.

The annual fishing regime, when developed and agreed-to by the co-managers through the PFMC and NOF forums, will be summarized and distributed to all interested parties, at the conclusion of annual pre-season planning. This document will summarize regulatory guidelines for Treaty Indian and non-Indian fisheries (i.e. species quotas, bag limits, time/area restrictions, and gear requirements) for each marine and freshwater management area on the Washington coast and in Puget Sound. Preseason forecasts and management agreements will be detailed in Management Status reports, as required by the Puget Sound Salmon management Plan. Regulations enacted during the season will implement these guidelines, but may be modified, based on catch and abundance assessment, by agreement between parties. In-season modifications shall be in accordance to the procedures specified in the PSSMP and subsequent court orders.

Further details on fishery regulations may be found in the respective parties regulation summaries, and other State/Tribal documents. The co-managers maintain a system for transmitting, cross-indexing and storing fishery regulations affecting harvest of salmon. Public notification of fishery regulations is achieved through press releases, regulation pamphlets, and telephone hotlines.

5.9 In-season Management

Fisheries schedules and regulations may be adjusted or otherwise changed in-season, by the co-managers or through other operative jurisdictions (e.g. the Fraser Panel, Pacific Fisheries Management Council). Schedules for fisheries governed by quotas, for example, may be shortened so that harvest quotas are not exceeded. Commercial net fishery schedules in Puget Sound may be modified to achieve allocation objectives or in reaction to in-season assessment of the abundance of target stocks, or of stocks harvested incidentally. In each case, the co-managers will assess the effect of proposed in-season changes with regard to their impact on natural chinook management units, and determine whether the management action constrains fishery impacts within the harvest limits stated in this plan. Particular attention will be directed to in-season changes that impact management units or populations in critical status, or where the pre-season plan projections indicated that total impacts were close to ceiling exploitation rates or projected escapement close to the respective escapement goals.

The co-managers will notify the NMFS when in-season management decisions will result in an exploitation rate higher than the relevant ceiling prescribed by this Plan or escapement less than the low abundance threshold for any management unit. The notification will include a description of the change, an assessment of the resulting fishing mortality, and an explanation of how impacts of the action still achieve the larger objective of not impeding recovery of the ESU.

5.10 Enforcement

Non-treaty commercial and recreational fishery regulations are enforced by WDFW. The WDFW Enforcement Program currently employs 163 personnel. Of that number, 156 are fully commissioned Fish and Wildlife officers who ensure compliance with licensing and habitat requirements, and enforce prohibitions against the illegal taking or poaching of fish and wildlife (www.wa.gov/wdfw/enf/enforce.htm). The Fish and Wildlife Enforcement Program is primarily responsible for enforcing the Washington State Fish and Wildlife Code (Title 57). However, officers are also charged with enforcing many other codes as well, and are often called upon to assist local city, county, other state, or tribal law enforcement agencies. On an average, officers currently make more than 300,000 fisheries-related public contacts annually (93% of Enforcement FTE's are field deployed). WDFW Enforcement also cooperates with the U.S. Fish and Wildlife Service, the NMFS Enforcement branch, and the U.S. Coast Guard in fisheries enforcement.

Each tribe exercises authority over enforcement of tribal commercial fishing regulations, whether fisheries occur on or off their reservation. In some cases enforcement is coordinated among several tribes by a single agency (e.g. the Point No Point Treaty Council is entrusted with enforcement authority over Lower Elwha Klallam, Jamestown S'Klallam, and Port Gamble S'Klallam, tribal fisheries). Enforcement officers of one tribal agency may be cross-deputized by another tribal agency, where those tribes fish in common areas. Prosecution of violations of tribal regulations occurs through tribal courts and governmental structures.

Participation by Indian and non-treaty fishers in pre-season fishery planning, at local meetings conducted by tribal resource managers and WDFW, and through the Pacific Fisheries Management Council hearings and the North of Cape Falcon forum, promotes education about salient conservation concerns that are of particular relevance to planning fisheries. These forums also promote a wide awareness of changes in regulations, well in advance of the onset of most fisheries, directly to fishers and through the news media.

6. Conservative Management

This chapter summarizes the conservative rationale and technical methods underlying the harvest management objectives of the Plan, noting how they have changed from previous management practices, and how they exceed the conservation standards of the ESA. As stated in Chapter 1, this Plan constrains harvest of all management units to the point where fishing mortality does not impede rebuilding and eventual recovery of the ESU. However, rebuilding and recovery is, for most populations, contingent on restoring the functionality of habitat. Harvest constraint will play an essential role in maintaining the existing diversity of populations that make up the ESU, by stabilizing, and in some cases increasing natural spawning escapement. However, rebuilding more robust population abundance, and effecting progress toward recovery, depends on the restoration of higher productivity that will only result from improved habitat quality.

The conservation standard of the ESA, as expressed in Limit 4 of the salmon 4(d) rule (50 CFR 223 vol 65 p 170 - 188) regarding state / tribal harvest management plans (Limit 6), is that harvest-related mortality must not "appreciably reduce the likelihood of survival and recovery of the ESU". The 4(d) rule defines 'survival and recovery' as protecting the abundance, productivity, and diversity of the ESU. . Limit 6 of the 4(d) rule asserts that harvest actions should: 1) maintain healthy populations at abundance above their recovery thresholds; 2) not impede the recovery of populations whose abundance is above their low threshold but below their recovery threshold; and 3) not impose increased demographic or genetic risk on populations at critically low abundance, unless imposing greater risk does not appreciably reduce the likelihood of survival and recovery of the entire listed ESU (50 CFR 223, 65(132): 42476).

The management objectives and constraints imposed by the Plan will maintain healthy populations (i.e., those at or near the abundance associated with recovery) by assuring that spawning escapement is sufficient for optimum productivity (MSH escapement). However the abundance of most of the populations in Puget Sound is well below the level associated with recovery, and in some cases is severely or chronically depressed. For some of these depressed populations, harvest constraint can only maintain escapement at the optimum level associated with current habitat quality. When that optimum level is not defined with certainty, harvest constraint will experimentally probe optimum capacity by providing higher numbers of spawners in some years, to better define current productive capacity. For very depressed populations, harvest will be severely constrained. Extraordinary measures defined by the Plan are expected to assure that the abundance of these populations will remain above their point of instability. However, because natural production (survival) is so reduced for these weak populations, some populations require hatchery supplementation for their maintenance Further harvest constraint would not materially improve the likelihood that these populations will survive in the long term.

Considering the significant influence that harvest has on abundance (i.e. spawning escapement), the objectives and conservation measures contained in this Plan were developed with specific intent to maintain all populations at their current status and allow them to rebuild as other constraining factors are alleviated. This chapter describes how the Plan's objectives protect the abundance and diversity of the ESU.

6.1 Harvest Objectives Based on Natural Productivity

The harvest objectives for each management unit are stated as ceiling exploitation rates or escapement goals for naturally spawning or, for some units, natural-origin chinook. Though fisheries in some areas are shaped to harvest surplus hatchery production, the primary objective is to assure protection and conservation of natural populations.

Specifying the objectives for all management units in terms of natural production is a significant change, when compared to past management practices. Formerly, management of some units was based primarily on harvesting surplus hatchery production, without regard to the consequences of these high harvest rates on natural-origin chinook. These units were designated 'secondary' in the Puget Sound Salmon Management Plan. This Plan imposes conservation constraints on harvest for all natural populations. It establishes specific escapement goals for Category II (formerly secondary) units, to ensure that natural production remains viable. For these units, in-season abundance assessment tools, followed by specific management responses when abundance falls short of the forecast level, will be implemented or under development.

Prior to 1998, chinook harvest objectives were stated as escapement goals for many Puget Sound management units. The PSSMP stated the preference that escapement goals be based on achieving maximum sustainable harvest, which implied the ability to quantify current natural productivity (i.e. spawner – recruit functions) and productive capacity. However, the escapement goals that were established by the co-managers for 'primary' management units were not always biologically based, but often consisted of an historical average of escapement during a period of relatively high abundance and survival, (i.e. 1968 - 1977 for summer fall stocks, 1959 - 1968 for Skagit River spring stocks). For most units, these historical escapements were a result of fishing levels in the base years, and were not related to the current capacity or quality of spawning or freshwater rearing habitat, or marine survival, particularly as habitat conditions were further degraded through the 1980s and 1990s. These goals were in effect until the late 1990s. Continuing decline in stock status, and the subsequent listing of Puget Sound chinook as threatened, with its requirement for development of recovery goals, prompted re-assessment of the old escapement goals, and development of new harvest objectives for many management units.

This Plan commits the co-managers to setting harvest and escapement objectives for all management units to conform with their current or recent productivity, to the extent the requisite data are available. Rebuilding exploitation rate ceilings may be developed and implemented, within the duration of this plan, for additional management units. For other units, even where current productivity is estimated, shaping of terminal fisheries to achieve escapement goals, particularly where in-season assessment provides more accurate estimates of abundance, will remain the preferred management approach. In-season assessment methods will be developed and refined, and escapement estimates refined, to improve the performance of escapement goal management.

6.2 Accounting for Uncertainty and Variability

Uncertainty and annual variability are inherent in estimating the productivity of salmon populations. In order to manage the associated risk, the derivation of biologically based harvest objectives must account and compensate for this uncertainty and variability. Methods outlined in Chapter 3, and described in detail in Appendix A, describe how the current procedure for developing rebuilding exploitation rates accomplishes this objective. This strategy may be summarized as follows:

- To the extent possible, variability in freshwater and marine survival rates will be quantified separately;

- Simulation of population dynamics will incorporate a range of values for marine and freshwater survival parameters that were typical of recent years, and therefore probably characteristic of the immediate future;
- Even when current survival is relatively high, as is currently believed to be the case for marine survival of Puget Sound populations, the simulation will assume lower survival in the future;
- Adaptive management will update these objectives as actual exploitation rates, escapement, and survival are monitored closely.

6.3 Protection of Individual Populations

This Plan establishes harvest limits (i.e. ceiling exploitation rates) for entire management units, but annual fishing planning will also pay specific attention to the status (i.e., projected spawning escapement) of individual populations, where a unit consists of more than one population, providing that data are available that quantify productivity and capacity for those populations. Annual exploitation rate targets will be influenced by escapement that is projected for each population, by the fishery simulation model, and the recent historical trend in population escapement. Actual exploitation rates, for most units, are likely to fall well below the exploitation rate ceilings, due to concern for weak or critical populations. Specific conditions are established for implementing fisheries that would increase the exploitation rate up to the ceiling for any unit. In order to guard against escapement declining to a level that may jeopardize demographic or genetic integrity, a low abundance threshold is established, for each population, as triggers for further constraint of harvest.

6.3.1 Populations exceeding their low abundance thresholds

Escapement for most Puget Sound chinook populations has, in recent years, exceeded the critical abundance threshold referred to in the 4(d) rule. Harvest of these populations is managed such that escapement, if habitat conditions allow, will attains or exceed the level associated with optimum current productivity (see Table 12) This assurance of stable or increasing escapement achieves the 4(d) standard of not impeding recovery of the ESU.

For populations with sufficient data, current productivity is quantified by spawner – recruit analysis (see Chapter 3). Freshwater conditions are highly variable, so ‘current’ productivity reflects the range of survival and recruitment rates observed in recent years. Exploitation rate ceilings are established for these units at the level consistent with achieving MSH escapement (Table 14) Implementation of this harvest plan will result in actual exploitation rates that are lower than that ceiling in most years, thereby intentionally exceeding MSH escapement under current conditions. The strategy of managing harvest under exploitation rate ceilings, as implemented under this plan, carries some risk of exceeding the spawning capacity of habitat, and lowering productivity, but will enable higher production should conditions in freshwater improve.

The strategy of this Plan is to probe the productivity of populations at increased escapement levels, and capitalize on favorable environmental conditions as they occur, or as habitat is restored. It also recognizes the current limits of management tools. Given the current accuracy of abundance forecasting, and the capability of the fishery simulation model, exploitation rates for a specified fishery regime can be projected with greater accuracy than spawning escapement. Exploitation rates may also be consistently and accurately estimated post-season, enabling continual, adaptive assessment of management performance.

The Plan sets also sets total exploitation rate objectives for the Puyallup fall and White spring populations that have been demonstrated to provide adequate seeding of spawning habitat. Analysis of the current potential of habitat (see Profile, Appendix A) suggests that the productivity is quite low in the Puyallup system, but returns from local hatchery production have contributed significantly to natural spawning and smolt production. Returns to the White River have increased, under the current exploitation rate objective, to levels well in excess of the low abundance threshold. Research is underway to refine estimates of current productivity and habitat capacity in these systems.

For other management units, exploitation rate ceilings are specified in this plan for southern U.S. fisheries, or ceilings are specified for pre-terminal fisheries in combination with specific terminal-area management measures, to assure that the naturally- populations remain viable. For the duration of this plan they will persist, at abundance substantially above their low abundance thresholds. The upper management threshold for some of these units may be achieved or exceeded in some years. For other units, the upper management threshold will be achieved only if existing habitat constraints are alleviated. Hatchery-origin chinook contribute to natural spawning in these systems, and provide a necessary measure of assurance that natural production will be stable or increase in these systems where habitat conditions cannot currently sustain abundance absent supplementation

6.3.2 Management Units In Critical Status

The critical or near-critical abundance expected for a small group of Puget Sound populations, will necessitate severe constraint of fisheries, in order to prevent further decline in their status, and achieve the conservation guidelines stated under Limit 6 of the 4(d) rule. For some populations (e.g. the North and South Fork Nooksack and Dungeness), recent natural-origin spawning escapement has been consistently below their low abundance thresholds (Table 3). Extraordinary fisheries conservation measures, described in Chapters 3 and 5, are prescribed by this Plan to prevent further decline in natural-origin spawner abundance.

For some other populations, escapement has in some years fallen below their low abundance thresholds (e.g., Lake Washington, Mid Hood Canal). Hatchery supplementation programs have maintained natural spawning abundance, in some cases well above their low threshold, for some populations (e.g. Stillaguamish, White, and Elwha), but natural productivity has been chronically depressed. As described in their management unit profiles (Appendix A) terminal area fisheries affecting these populations have, in recent years, been constrained or eliminated, as if they were in critical status. Upper management thresholds been established for these populations, but, because of their status, the objective most relevant to current management is their low abundance threshold. Habitat-based analyses of productivity indicate that the upper management threshold is substantially higher than current MSH for the North Fork and South Fork Nooksack, Mid-Hood Canal, and Dungeness populations. However, the management intent is to exceed current MSH escapement as often as possible, to guard against the uncertain ecological and genetic risks of low abundance.

Table 12. Escapement levels (upper management thresholds) consistent with optimum productivity or capacity under current habitat conditions, and recent escapement for Puget Sound chinook management units

Management Unit	Upper Mgmt Threshold [1]	1997	1998	1999	2000	2001	2002
Nooksack early	4000 [2]	254	194	251	444	531	513
Skagit spring	2000 [3]	1041	1086	471	1021	1856	1065
Skagit sum / fall	14500 [3]	4872	14609	4924	16930	13793	19591
Stillaguamish S/F	900 [4]	1156	1540	1098	1646	1349	1588
Snohomish S/F	4600 [5]	4292	6304	4799	6092	8164	7220
L. Washington Cedar River	1200 [6]	227	432	241	120	810	369
Green R.	5800 [7]	9967	7300	9100	6170	7975	13950
White R. spring	1000 [8]	400	316	553	1523	2002	803
Puyallup	1200 [9]	1550	4995	1986	1193	1915	1,590
Nisqually	1100 [10]	340	834	1399	1253	1079	1,542
Skokomish	3650 [11]	2337	6761	9119	4959	10729	1,479
Mid Hood Canal	750 [12]	N/A	287	873	438	322	65
Dungeness	925 [13]	50	110	75	218	453	633
Elwha River	2900 [14]	2517	2358	1602	1851	2208	2,376
Juan de Fuca Hoko River	850 [15]	765	1618	1497	612	768	645

[1] Management threshold from quantified current productivity or best available estimate of current habitat capacity
[2] Nooksack Endangered Species Action Team 2000.
[3] Hayman 2003,
[4] Stillaguamish management unit profile (Appendix A)
[5] Snohomish management unit profile (Appendix A)
[6] Hage et al. 1994.
[7] Ames and Phinney 1977.
[8] WDFW et al 1996. Natural-origin spawners transported past Mud Mountain Dam
[9] Puyallup citation?.
[10] Nisqually Chinook Recovery Team. 2001. Nisqually Chinook Recovery Plan.
[11] Ames and Phinney 1977. Composite of 1,650 natural spawners and hatchery escapement target of 2000.
[12] U.S. v. Wash. Civil 9213, Ph. I (Proc. 83-8). Order Re: Hood Canal Management Plan (1985).
[13] Smith and Sele 1994.
[14] Ames and Phinney 1977. Composite of 500 natural and 2,400 hatchery escapement. Hatchery is listed as essential to recovery.
[15] Ames and Phinney 1977. Modified to exclude capture of adults for supplementation program.

6.4 Equilibrium Exploitation Rates

Managing harvest under rebuilding exploitation rate ceilings assures stable or increasing escapement for those management units. The underlying recruitment function, which is based on current performance, predicts that productivity declines as abundance (escapement) increases, such that for any level of escapement an exploitation rate may be identified that assures replacement of the parent brood. Setting the rebuilding exploitation rate objective conservatively, with a view to recent abundance, assures a high probability that escapement will trend upward. The following analysis illustrates this concept for the Skagit River summer / fall and spring management units.

The equilibrium exploitation rate at each level of spawning escapement (i.e., the exploitation rate that would, on average, maintain the spawning escapement at the same level) was calculated from the Ricker spawner-recruit parameters used in the RER analyses that set the ER ceilings for each management unit. These equilibrium rates are represented by the curve that forms the border between the shaded and white regions in Figures 6 and 7. Note that, due to declining productivity, the equilibrium ER *decreases* as escapement increases. In the region below this curve (i.e., the exploitation rate is lower than the equilibrium rate that applies to that level of spawning escapement), escapement should, on average, increase in the next cycle. In the region above this curve, escapement should, on average, decrease in the next cycle.

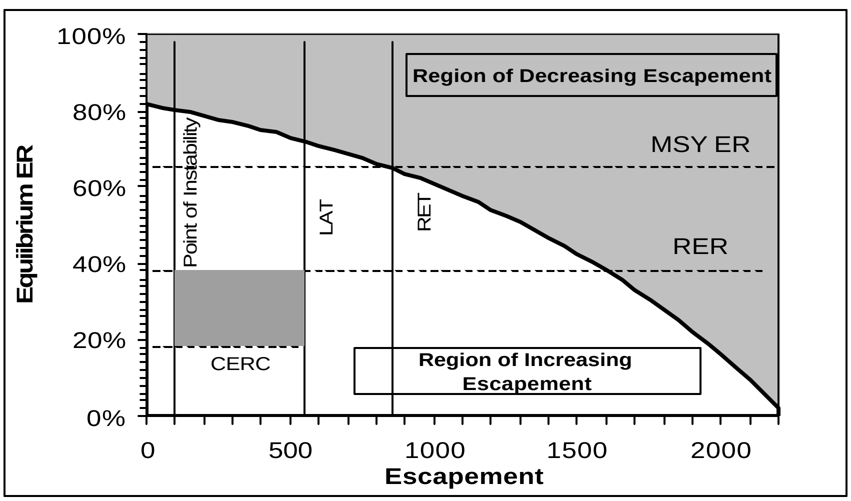
For Skagit chinook, NMFS' "viable threshold" is the same thing as the "rebuilding escapement threshold" that was used in the RER analyses to set the ER ceiling. For Skagit spring chinook, this is the MSY escapement level, which, from the Ricker spawner-recruit parameters that were used in the RER analysis, is about 850 spawners (Fig. 6). The Limit 6 "critical threshold", however, is NOT the same thing as the "critical threshold" defined in this plan – the Limit 6 threshold is a point of instability below which the spawner-recruit relation destabilizes and the risk of extinction increases greatly. The low abundance threshold in this plan, in contrast, is a buffered level that is set sufficiently *above* the point of instability that the risk of getting an escapement below the point of instability, through management error or uncertainty, is low. The critical threshold for Skagit spring chinook, in this plan, is 576 spawners; the point of instability (i.e., the Limit 4 "critical threshold"), calculated using the Ricker parameters from the RER analysis and Peterman's (1977) rule-of-thumb, (i.e., that the point of instability is 5% of the replacement level), would be about 110 spawners (Fig. 6)."

The plan mandates that, if escapement is projected to fall below the LAT, SUS fisheries will be constrained to exert an exploitation rate less than or equal to the CERC, though the total exploitation rate may range higher, as shown in the crosshatched region in Figure 6, due to northern fisheries.

For Skagit spring chinook, when abundance is between the point of instability and the viable threshold, this plan's ER ceiling is well within the region of increasing escapement (Fig. 6), which satisfies the criterion that the plan must allow abundances in this range to increase to the viable level. In fact, even ER's significantly *above* the ER ceiling satisfy this criterion. For escapements greater than the viable threshold, the ER ceiling allows for increasing escapements up to the point where the ER ceiling intersects the equilibrium ER curve. This occurs at an escapement of about 1700 (Fig. 6). For escapements above that level, if harvest met the ER ceiling each year (which is not what is expected under this plan), escapements would tend to decrease in the next cycle; however, they would be expected to stabilize around an escapement of about 1700, which is well above the viable threshold. Thus, the plan also satisfies the criterion that, for escapements above the viable threshold, abundance will, on average, be maintained in that region.

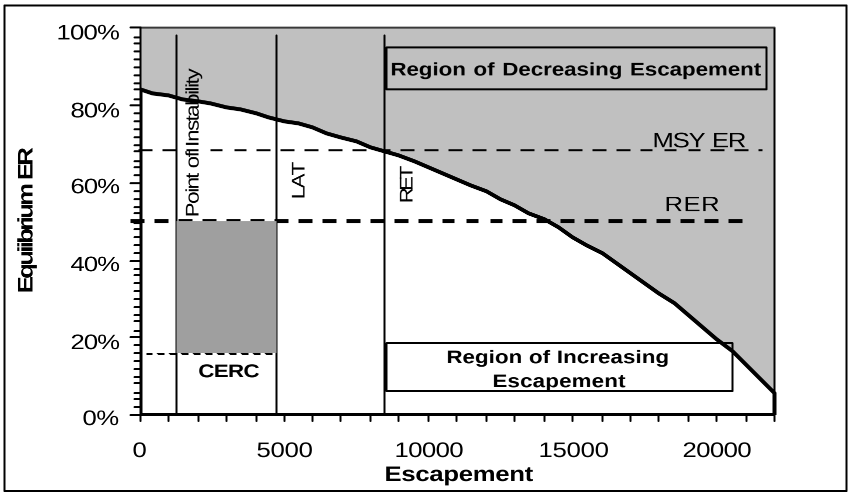
For escapements below the point of instability, recruitments will, by definition, be inconsistent and largely unrelated to the escapement level. This means that harvest management cannot be used effectively to increase escapements above the point of instability. Rebuilding above this level could only be accomplished through fortuitous returns or increase in productivity. This plan deals with abundances below the point of instability largely by trying to prevent abundance from getting that low. For Skagit springs, the trigger for reducing SUS impacts to the minimum regime occurs at a threshold of 576, which is over 5 times higher than the calculated point of instability, and, at that threshold and exploitation rate, is well within the region of increasing escapement (Fig. 6). In the event that abundance falls below the point of instability, and then was followed by a fortuitous recruitment that exceeded that level, the ceiling exploitation rate is low enough that equilibrium momentum will tend to increase the escapement further, rather than reduce it to below the point of instability again. Thus, this plan should not increase the genetic and demographic risk of extinction for Skagit springs. In practical application, the lowest observed Skagit spring chinook escapement has been 470 (in 1994 and 1999), which is over 4 times higher than the calculated point of instability – escapements have exceeded 1,000 during each of the last 3 years, which is higher than the viable threshold, and again indicates that this plan should not increase the genetic and demographic risk of extinction for Skagit springs.

Figure 6. The equilibrium exploitation rate, at each escapement level, for Skagit spring chinook. Exploitation rates below the curve should, on average, result in higher escapements on subsequent cycles; exploitation rates above the curve should, on average, result in lower escapements on subsequent cycles. Equilibrium rates were calculated from the Ricker parameters that were used for the RER analysis used to set the ER ceiling for the Skagit spring chinook management unit. The MSY exploitation rate (MSY ER), rebuilding exploitation rate (RER), and critical exploitation rate ceiling (CERC), and three escapement levels – the calculated point of instability, the low abundance threshold (LAT), and the rebuilding escapement threshold (RET), are marked for reference (see text)



For Skagit summer/fall chinook, the rebuilding escapement threshold is approximately 8500 spawners; the low abundance threshold is 4800; and the calculated point of instability is approximately 1100. As with Skagit springs, in the range between the point of instability and the MSH escapement level, the ER ceiling is well within the region of increasing escapement (Fig. 7), which satisfies the criterion that the plan must allow abundances in this range to increase to the viable level. For escapements greater than the calculated MSH level, the ER ceiling allows for increasing escapements up to an escapement of about 13,500 (Fig. 7). If escapement was higher than that, and harvest met the ER ceiling each year (which, again, is not what is expected under this plan), escapements would be expected to stabilize around an escapement of about 13,500, which is well above the viable threshold. Thus, this plan also satisfies the criterion that, for escapements above the viable threshold, summer/fall abundance will, on average, be maintained in that region.

Figure 7. The equilibrium exploitation rate, at each escapement level, for Skagit summer/fall chinook.
Exploitation rates below the curve should, on average, result in higher escapements on subsequent cycles; exploitation rates above the curve should, on average, result in lower escapements on subsequent cycles. Equilibrium rates were calculated from the Ricker parameters that were used for the RER analysis used to set the ER ceiling for the Skagit summer/fall chinook management unit. The MSY exploitation rate (MSY ER), rebuilding exploitation rate (RER), and critical exploitation rate ceiling (CERC), and three escapement levels – the calculated point of instability, the low abundance threshold (LAT), and the rebuilding escapement threshold (RET), are marked for reference (see text).



As previously noted for Skagit spring chinook, the combined impacts from northern fisheries and constrained SUS fisheries, that would be implemented if the summer / fall unit were to decline to critical status, would be expected to exert total exploitation rates well below the equilibrium rate, and assure higher subsequent escapement *well below the equilibrium ER* that applies to escapements between the LAT and the point of instability, so, on average, equilibrium pressures would force escapement to increase.

As with spring chinook, it is not possible to project any relation between escapement and recruitment for escapements below the point of instability. To prevent summer/fall escapements from falling below this level, the trigger for reducing SUS impacts to the minimum regime occurs at a threshold of 4800, which is over 4 times higher than the calculated point of instability, and, at that threshold and exploitation rate, is well within the region of increasing escapement (Fig. 7). The same equilibrium momentum would, on the next cycle, tend to increase escapements further, rather than reduce them, if escapement did drop below the point of instability and then experienced a fortuitous recruitment. In terms of actual observations, the lowest observed Skagit summer/fall chinook escapement has been 4900 (in 1997 and 1999), which is over 4 times higher than the calculated point of instability, and escapement has exceeded 13,500 during each of the last 3 years, which is well above the calculated MSH escapement level. Thus, for Skagit summer/fall chinook, this plan should not increase the genetic and demographic risk of extinction.

6.5 Reduction in Exploitation Rates

The annual exploitation rate targets that will result from implementing this Plan will likely be substantially lower than the rates that occurred in the 1980s. Annual exploitation rates for Category 1 management units have declined 44 to 64 percent, based on comparison of the 1983-1987 and 1998 -2000 average rates estimated by post-season FRAM runs (Table 13). Pre-season model projections confirm that total exploitation rates are being held to this low level in the past three years. Exploitation rates in Washington fisheries (ocean and Puget Sound areas combined) have fallen 28 to 77 percent for Category 1 units.

Table 13. Decline in average total, adult-equivalent exploitation rate, from 1983 – 1987 to 1998-2000, and 2001 – 2003, for Category 1 Puget Sound chinook management units (post-season FRAM estimates for 1983 – 2000, preseason estimates for 2001- 2003).

	83-87 Avg	98-00 Avg	% Decline	01 - 03 Avg	% Decline
Skagit S/F	0.67	0.27	59.7%	0.34	49.0%
Stillaguamish	0.54	0.19	64.1%	0.15	71.2%
Snohomish	0.59	0.26	56.4%	0.20	66.8%
Green	0.65	0.36	44.1%	0.49	24.0%
Nooksack Spr	0.43	0.16	63.3%	0.17	60.1%
Skagit Spr	0.60	0.26	56.6%	0.22	62.8%
White	0.52	0.20	60.5%	0.19	62.8%
JDF	0.76	0.38	50.7%	0.18	76.5%

In consequence, the actual risk incurred by management units with RER objectives will be lower than the 4(d) risk criteria used to select the RERs. The probability of achieving the upper management threshold, or current MSH escapement, will be higher than 80%, and the probability of falling to critical abundance will also be reduced. For MUs without RER objectives, Table 12 suggests that risks due to excessive harvest pressure have already been substantially eliminated.

6.6 Recovery Goals

The Washington co-managers have identified recovery goals for several Puget Sound management units, based on quantitative assessment of the potential productivity associated with recovered habitat conditions (Table 14). These interim planning targets are intended to assist local governments, resource management agencies, and public interest groups with identifying harvest and hatchery management changes, and habitat protection and restoration measures necessary to achieve recovery in each watershed and the ESU as a whole. Recovery goals are expressed as a range of natural-origin or natural spawning escapement and associated recruitment rates (i.e. adult recruits per spawner). The lower boundary represents the number of spawners that will provide maximum surplus production (i.e. MSH) under properly functioning habitat conditions, assuming recent marine survival rates. The upper boundary represents the equilibrium escapement under these conditions, (i.e. the number of adults surviving to spawn is equal to the parent brood-year escapement).

In most cases, the management objectives (upper management thresholds), and recent escapements, are substantially below the lower end of the recovery range (see section 6.7, below), reflecting their different points of reference with regard to habitat quality. Notable exceptions include the Upper Skagit summer, Cascade Spring, and Siuattle Spring populations, where recent escapement has exceeded the lower boundary of the recovery goals. These three examples notwithstanding, upper management thresholds represent MSH escapement under current habitat conditions, and imply that current conditions limit the potential for recovery for most populations.

Table 14. Escapement levels and recruitment rates for Puget Sound chinook populations, at MSH and at equilibrium, under recovered habitat conditions.

Population	MSH		Equilibrium Escapement [1]
	Escapement	Adult R/S	
North Fork Nooksack	3,400	3.3	14,000
South Fork Nooksack	2,300	3.6	9,900
Upper Cascade Spring	290	3.0	1,160
Suiattle Spring	160	2.8	610
Upper Sauk Spring	750	3.0	3,030
Lower Skagit Fall	3,900	3.0	15,800
Upper Skagit Summer	5,380	3.8	26,000
Lower Sauk Summer	1,400	3.0	5,580
North Fork Stillaguamish	4,000	3.3	18,000
South Fork Stillaguamish	3,600	3.4	15,000
Snoqualmie	5,500	3.6	25,000
Skykomish	8,700	3.4	39,000
Puyallup	5,300	2.3	18,000
Nisqually	3,400	3.0	13,000
Mid Hood Canal	1,320	2.9	5,200
Dungeness	1,170	3.0	4,740

[1] Recruitment (returns per spawner) at equilibrium, by definition, equals 1.0.

With the exceptions noted above, the recovery goals are not of immediate relevance to current harvest management objectives. A subset, at least, of management units will have recover for the ESU to be de-listed, but ESU recovery (i.e. that subset or alternative subsets of recovered units) has not been defined. The recovery goals, as stated by the co-managers, exceed the increase in abundance and productivity necessary for delisting.

6.6.1 Harvest Constraint Cannot Effect Recovery

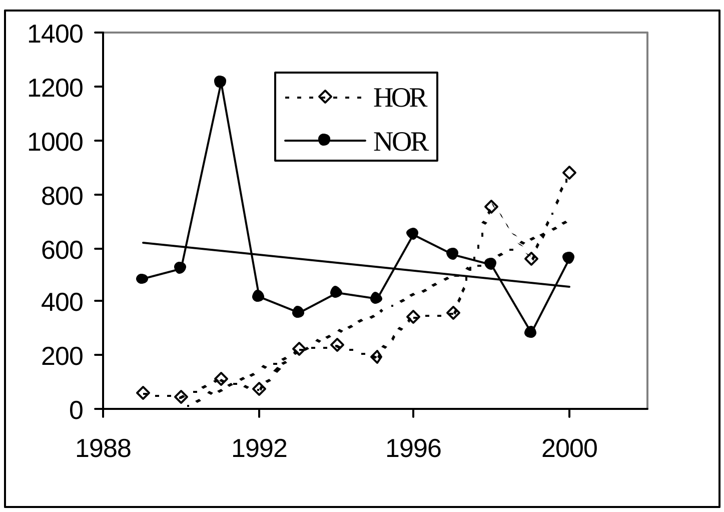
Population recovery (i.e., increase in abundance to levels well above the stated upper thresholds, for most populations) cannot be accomplished solely by constraint of harvest. If harvest mortality is not excessive, and spawning escapement is not reduced to the point where depensatory mortality and other ecological factors become significant and threaten genetic integrity, harvest does not affect productivity. Productivity is primarily constrained by the quality and quantity of freshwater and estuarine environment that determines embryonic and juvenile survival, and oceanic conditions that influence survival up to the age of recruitment to fisheries.

Physical or climatic factors, such as stream flow during the incubation period, will vary annually, and are expected in some years to markedly reduce smolt production. The capacity of chinook to persist under these conditions is primarily dependent on their diverse age structure and life history, and habitat factors (e.g. channel structure, off-channel refuges, and watershed characteristics that determine runoff) that mitigate adverse conditions

For several Puget Sound populations, mass marking of hatchery production has enabled accurate accounting of the contribution of natural- and hatchery-origin adults to natural escapement. Sufficient data has accumulated to conclude that a significant reduction of harvest rates, in concert with increased marine survival, has increased the number of hatchery-origin fish that return to spawn, whereas returns of natural-origin chinook, though stable, have not increased. It is evident that natural production has not increased under reduced harvest pressure, and is constrained primarily by the condition of freshwater habitat. Therefore, the current, relatively low, harvest rates proposed in the HMP, are not impeding recovery.

These escapement data are also available for the North Fork Nooksack and Skykomish populations, but the North Fork Stillaguamish trend is cited here as an example. Fingerlings released by the summer chinook supplementation program are coded wire tagged, enabling accurate estimation of their contribution to escapement. Harvest exploitation rates have fallen 70% since the late 1980s (Table 12). The return of hatchery-origin chinook has increased markedly, exceeding 800 in 2000, while natural-origin returns have remained relatively stable, averaging 522 in the last five years. (Figure 8),

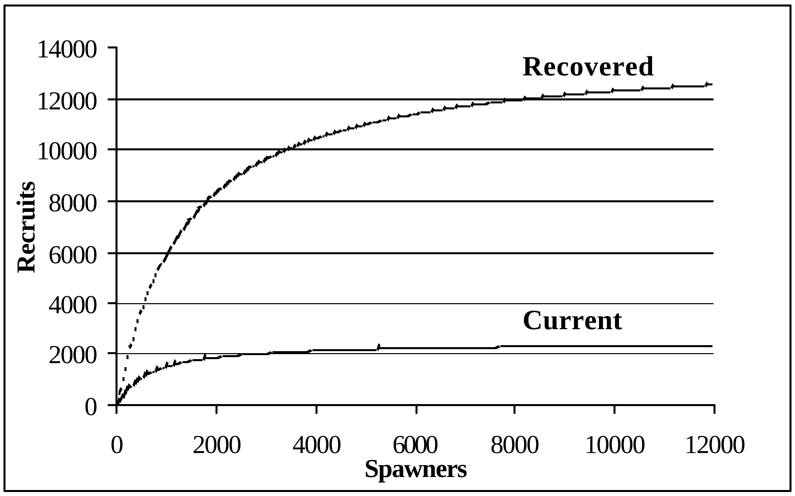
Figure 8. The return of natural-origin (NOR) chinook to the North Fork Stillaguamish River has not increased, while the number of hatchery-origin adults (HOR) have increased significantly under reduced harvest rates



Harvest constraint has, for most populations, resulted in stable or increasing trends in escapement on the spawning grounds (for many populations this includes a large proportion of hatchery-origin adults). But the trend in NOR returns strongly suggests that, although escapement may be stable or even trend upward toward or above the optimum (MSH) level associated with current habitat condition, NOR recruitment will not increase much beyond that level unless constraints limiting freshwater survival are alleviated. Habitat quality appears to be the biggest constraint on freshwater productivity.

Spawner-recruit functions for the North Fork Stillaguamish population, under current and recovered habitat conditions, provide an example (Figure 9). Derived from EDT analysis of habitat capacity under current and recovered conditions, they demonstrate that natural production is now constrained to a ceiling (asymptote) far below that associated with recovery ('properly functioning condition' or 'PFC+').

Figure 9. Productivity (adult recruits) of North Fork Stillaguamish summer chinook under current and recovered habitat (PFC+) conditions. Beverton-Holt functions derived from habitat analysis using the EDT method.



The reduction of harvest pressure in SUS fisheries has, at least, stabilized NOR escapement, and the listed hatchery supplementation program further guards against catastrophic decline. While acknowledging the risk of density dependent effects, implementing the HMP will experimentally test production at these higher escapement levels, and capitalize on favorable freshwater survival conditions that may occur. Under the current harvest objectives, NOR escapement may achieve the current MSH level, but a significant increase in productivity will be necessary for the population to recover. Further harvest constraint will not, by itself, effect an increase above the asymptote associated with current productivity, until habitat conditions improve.

Very similar conclusions can be drawn from examination of current NOR escapement trends in the North Fork Nooksack, Skykomish, and Dungeness rivers. In these systems, NOR returns have remained at very low levels, while total natural escapement has increased where hatchery supplementation programs exist. The contrast between current productivity, and the higher level of recruitment possible under restored habitat condition is marked in all cases.

6.7 Protecting the Diversity of the ESU

The Plan includes management objectives for 21 chinook populations in the Puget Sound ESU, and the one population (the Hoko River) in the western SJDF. The HMP provides a high degree of assurance that, within its six-year duration, all of these populations will persist. The Plan asserts that all extant populations are valuable diversity elements of the ESU. It will allow some populations to reach their viable thresholds, hold others at stable abundance levels, well above their critical thresholds, and assure persistence of those at or near critical abundance. It assures that no population will decline to extinction as a result of harvest.

Highly conservative management objectives are established for the eight natural populations in the Skagit and Snohomish systems. Despite habitat constraints in their watersheds and estuaries, these core populations, in the aggregate, comprise abundant and essential natural production by indigenous stocks that is not dependent on hatchery augmentation. These populations inhabit large watersheds, with habitat, capable of supporting genetically diverse subpopulations of chinook with diverse life histories. The Plan, therefore, emphasizes protection of these core populations which, for the foreseeable future, comprise the strongest element of the ESU, given the uncertainty about recovery of production in other more densely developed and degraded watersheds Protection of these core populations is essential to the integrity of the ESU.

Management objectives for these populations are based on a low tolerance for risk of decline to critical status. Should survival rates and abundance decline, ceiling exploitation rates for SUS fisheries would be reduced. This lower exploitation rate would be well below the equilibrium ER (see section 6.4) that applies to escapements between the LAT and the point of instability, so, on average, equilibrium pressure would force escapement to increase. The rebuilding exploitation rate ceiling provides similar assurance that, given sufficient abundance, under current productivity (survival) conditions, escapement will achieve the level associated with optimum productivity (MSH), as defined by the rebuilding escapement threshold. Escapement will increase, even at exploitation rates higher than the RER, according to the equilibrium exploitation rate assessment, so the RER ceiling gives assurance of not impeding rebuilding. Furthermore, annual target exploitation rates for these populations are expected to be substantially lower than their respective ER ceilings, in most years, thus further improving the probability that escapement will increase or remain at optimum levels. .

Indigenous populations persist in the North Fork Nooksack, North and South Forks of the Stillaguamish River, the Cedar River, the White River, the Green River, the Elwha River and the Dungeness River. Natural spawning is supplemented by hatchery production in the North Fork Nooksack, North Fork Stillaguamish, White, Green, Elwha, and Dungeness rivers, and, for the foreseeable future, will be required, in order to maintain these populations at current abundance levels. Non-indigenous populations persist, and are supplemented by hatchery production, in the Puyallup, Nisqually, and Skokomish rivers.

Except for the Stillaguamish system, the productivity of the naturally spawning chinook in these systems is not yet quantified. Rebuilding exploitation rate and critical exploitation rate ceilings for the Stillaguamish populations provide the same kind of risk-averse management objectives provided for the core, larger populations described above. Habitat-based analysis (EDT), or other information, suggests that natural productivity is very low in the remainder of these systems. Constrained fishing exploitation rates will continue to assure that escapement to natural spawning areas will meet or exceed current escapement goals.

The ecological and genetic risks associated with hatchery supplementation programs, as well as their benefits to ESU diversity and harvest opportunity, have been addressed and considered in the Puget Sound Chinook Hatchery Management Plan (2003). For most of these populations the benefits provided by hatcheries in maintaining higher levels of natural production and continued harvest opportunity may outweigh their ecological or genetic risks. Fishery constraints, by either exploitation rate ceilings and / or escapement goals, are expected to maintain the current status of these ten populations, well above their low abundance thresholds. For the remaining populations, pre-terminal or total SUS harvest is constrained by ER ceilings, and terminal fisheries are carefully structured to meet, and in many cases exceed, natural escapement goals. For the populations whose abundance has been at critical or near-critical levels in the recent past (e.g. the

Nooksack, Stillaguamish, Cedar[3], and White rivers), terminal-area harvest has been and will continue to be tightly constrained to minimize even the small remaining incidental fishery mortality. Rebuilding of abundance to viable levels for these populations may be a long-term prospect (100+ years), dependent on alleviating habitat constraints. The potential for recovery may be higher in drainages that are not heavily urbanized or developed for industrial purposes, such as the Nooksack, the Stillaguamish, and the Elwha systems, providing that stringent habitat protection measures are implemented. Habitat protection and restoration is being aggressively pursued in each watershed.

Populations with critically low abundance are present in the South Fork Nooksack, Mid-Hood Canal, and Dungeness rivers. A hatchery supplementation program has increased the returns to the Dungeness system in recent years, and affords assurance that this population will not become extinct. Harvest mortality of these populations, in SUS waters, is highly constrained because of their critical status, and because the precision of fishery simulation modeling for these small populations is subject to error. The harvest plan, by imposing very low SUS exploitation rate ceilings, will ensure that their risk of extinction is not increased, and will provide sufficient escapement to these rivers to allow these populations to persist in the near term. Critical exploitation rate ceilings will assure small but significant increases in the proportion of each population that escapes to spawn, and maintenance of their genetic diversity. However, given the status of the South Fork Nooksack and Mid-Hood Canal populations, the comanagers will consider the need for artificial supplementation programs to protect them against extinction.

The limits on harvest mortality provided by this plan, or further reduction of incidental harvest mortality in SUS fisheries, will not, by themselves, provide assurance of increased abundance or viability. They can only contribute to recovery of the ESU if habitat constraints are alleviated.

The role of harvest management to enable recovery of the ESU is to ensure that spawning escapement is sufficient to optimize the productivity of populations, in the context of current habitat conditions. Harvest objectives and their implementation will compensate for the uncertainty in productivity and for management error. The constraints on harvest exerted by the HMP assure that the majority of any increase in abundance associated with favorable survival in the freshwater or the marine environment, will accrue to escapement, in order to facilitate increased future production that benefits from the improved productivity conditions. Implementation of the HMP will, in general, allow escapements higher than the current MSH level, to capitalize on the production opportunity provided by favorable, higher freshwater survival conditions. For populations with more uncertain current productivity, implementation will provide stable natural escapement (in many cases considerably higher than the optimum level likely under current conditions) to preserve options for recovering production throughout the ESU in the long term.

In summary, the HMP provides a high degree of assurance that, for the next six years, the core indigenous populations in the Puget Sound ESU will continue to rebuild, and that all other populations will persist at, or above, their current abundance. A recovered ESU will necessarily include regional balance (i.e. geographic and diversity). The NMFS has not yet defined which of the extant populations are essential to a recovered ESU, so the qualifying language in the 4(d) rule, with respect to non-essential populations, does not provide a criterion for the adequacy of this plan. Clearly, systems where non-indigenous populations have been established through

[3] An independent population may also exist in the northern tributary streams of Lake Washington, but specific management objectives for that population await development of key information regarding the abundance and distribution of natural-origin chinook in those streams.

hatchery programs also comprise valuable elements of geographic and genetic diversity. But the ability of harvest management to preserve all existing diversity is limited. Despite the optimism created by the complex recovery planning effort now underway, the current diversity of the ESU may not persist unless habitat constraints are alleviated, thus allowing the natural productivity of chinook population to increase. For those populations that are unlikely to recover in the near term, due to habitat constraints, the HMP preserves the future option to recover if the collective societal will is exerted to preserve their habitat.

6.8 Summary of Conservation Measures

1. Exploitation rates have been substantially reduced from past levels. The fisheries constraints in this plan will keep ER's at low rates.

2. Exploitation rate ceilings established for each management unit using the best available biological information, have been shown to achieve a high degree pf probability of stable abundance under current habitat constraints, while not impeding recovery to higher abundance as habitat conditions and marine survival allow.

3. Rebuilding exploitation rates are ceilings, not annual targets for each management unit. Under current conditions most management units are not producing a harvestable surplus, as defined by this plan, so weak stock management procedures that assure meeting conservation needs of the least productive unit(s) forces the annual target rates for most units below the RER ceiling. Projected ER's in 2000 – 2002 for the Skagit, Stillaguamish, and Snohomish management units were substantially below their respective ceiling rates (Table 15).

Table 15. Annual projected total exploitation rates compared with RERs for natural chinook management units in Puget Sound.

Management Unit	RER	Projected ER			
		2000	2001	2002	2003
Skagit summer/fall	52%	26%	38%	24%	48%
Skagit spring	42%	21%	22%	24%	23%
Stillaguamish summer/fall	25%	13%	17%	14%	17%
Snohomish summer/fall	35% (2000); 32% (2001-02); 24% (2003)	20%	21	18%	19%

4. If a harvestable surplus is available for any management unit, that surplus will only be harvested if a fishing regime can be devised that is expected to exert an appropriately low incidental impact on weaker commingled populations, so that their conservation needs are fully addressed.

5. Exploitation rate objectives will be met for each MU, unless interceptions in Canadian and Alaskan fisheries increase to the extent that unacceptable further reductions in Washington fishing opportunity, on harvestable chinook or species, is necessary to achieve those objectives.

6. If annual abundance is forecast to result in escapement at or below the low abundance threshold, SUS fisheries exploitation rate will be further reduced to the CERC. The low abundance thresholds are intentionally set at levels substantially higher than the actual point of biological instability, so that fisheries conservation measures are implemented to prevent abundance falling to that point.

7. High exploitation rates in the past may have selected against larger, older spawners, thereby changing the age composition or reducing the size of spawning chinook. To the extent that this has occurred, the reduction in exploitation rates required under this plan will increase the proportion of larger, older spawners. The potential for size-, age-, and sex-selective effects of fisheries on spawning chinook are reviewed in Appendix F.

8. The reduction in exploitation rates required under this plan will increase the number of chinook carcasses on the spawning grounds. Any increase in productivity that results from this increase in carcasses will accelerate recovery beyond what was assumed when deriving the ceiling ER's (see Chapter 8 and Appendix D for a more detailed discussion of the nutrient re-cycling role of salmon carcasses).

9. Under all conditions of management unit status, whether critical or not, the co-managers maintain the prerogative to implement conservation measures that reduce fisheries-related mortality farther below any ceiling stated in this Plan. Responsible resource management will take into account recent trends in abundance, freshwater and marine survival, and management error for any unit.

7. Monitoring, Assessment and Adaptive Management

The performance of the fishery management regime will be evaluated annually, to assess whether management objectives were achieved, and identify the factors contributing to success or failure of management. This performance assessment will be documented in an annual report, to be completed by mid-February each year for reference during the annual fishery management planning process.

While much of the information in the annual report will be preliminary, and it can only point to major events, the annual review is intended to inform the co-managers of any significant reasons for possible deviations from expected outcomes in the immediately preceding season. To the extent possible, the co-managers will use this information to assess whether these deviations were caused by the management system, or to unpredictable variation in the catch distribution of the various management units, migration timing, freshwater entry timing, or other environmental and behavioral factors. Management system inaccuracies might include error or bias in abundance forecasts, inaccuracy or bias in the FRAM fishery simulation, inaccurate in-season abundance assessment tools, or the failure of specific regulations to constrain harvest-related impact in the desired manner.

The co-managers recognize that some degree of inaccuracy and imprecision is inherent in these aspects of the management system. The intent of the annual review is to detect significant and consistent inaccuracies that may become problematic over the short term, and to adjust existing tools or devise new tools, to address them.

7.1 Monitoring and Evaluation

The Northwest Washington Indian Tribes and the Washington Department of Fish and Wildlife (WDFW), independently and jointly conduct a variety of research and monitoring programs that provide the technical basis for fisheries management. These activities were mandated by the PSSMP in 1985, though activities related to chinook management have evolved as management tools have improved. Monitoring and assessment essential to the management of Puget Sound chinook is described in detail below, with discussion of how the information is used to validate and improve management regimes. This section is not an exhaustive inventory of chinook research. A wide variety of other studies are underway to identify factors that limit chinook production in freshwater, and to monitor the effectiveness of habitat restoration.

7.1.1 Catch and fishing effort

Chinook harvest in all fisheries, including incidental catch, and fishing effort are monitored and compared against pre-season expectations. Commercial catch, and ceremonial, subsistence, and 'take-home' harvest in Washington waters are recorded on sales receipts ('fish tickets'), copies of which are sent to WDFW and tribal agencies and recorded in a jointly maintained database. A preliminary summary of catch and effort is available four months after the season, though a final, error-checked record may require a year or more to develop.

Catch and effort are estimated in-season for certain chinook fisheries that are limited by catch quotas, such as the ocean troll and recreational fisheries that are managed under the purview of the Pacific Fisheries Management Council. Recreational catch in Areas 1 – 6 is estimated in-season by creel surveys. Creel sampling regimes have been developed to meet acceptable standards of variance for weekly catch.

For other Puget Sound fishing areas, recreational harvest is estimated from a sample of catch record cards obtained from all anglers. The baseline sampling program for recreational fisheries provides auxiliary estimates of species composition, effort, and catch per unit effort (CPUE) to the Salmon Catch Record Card System. The baseline sampling program is geographically stratified among Areas 5-13 in Puget Sound. For this program, the objectives are to sample 120 fish per stratum for estimation of species composition, and 100 boats per stratum for the estimation of CPUE.

Catch and effort summaries allow an assessment of the performance of fishery regulations in constraining catch to the desired levels. Time and area constraints, and gear limitations, are imposed by regulations, but with some uncertainty regarding their exact effect on harvest. For many fisheries, catch is often projected preseason based on the presumed effect of specific regulations. Post-season comparison to actual catch assesses the true effect of those regulations, and guides their future application or modification.

Incidental mortality in fisheries directed at other species has comprised an increasingly significant proportion of the total harvest mortality of Puget Sound chinook, after the elimination of most directed harvest . For many commercial net fisheries in Puget Sound, incidental mortality is projected by averaging a recent period, either as total chinook landed or as a proportion of the target species catch. Recent-year data are the basis for continually updating these projections.

Non-landed mortality of chinook is significant for commercial troll, recreational hook-and-line, and certain net fisheries, regulations for which may mandate release of sub-adult chinook, or all chinook, during certain periods. Studies are periodically undertaken to estimate encounter rates and hooking mortality for these fisheries. Findings from these studies are required to validate the encounter rates and release mortality rates used in fishery simulation models.

Higher priority has been assigned to sampling the catch from certain terminal-area fisheries, to collect biological information about mature chinook. Collection of scales, otoliths, and sex and length data will characterize the age and size composition of the local population, and distinguish hatchery- and natural-origin fish.

7.1.2 Spawning escapement

Chinook escapement is estimated from surveys in each river system. A variety of sampling and computational methods are used to calculate escapement, including cumulative redd counts, peak counts of live adults, cumulative carcass counts, and integration under escapement curves drawn from a series of live fish or redd counts. A detailed description of methods used for Puget Sound systems is included in Appendix E.

Escapement surveys also provide the opportunity to collect biological data from adults to determine their age, length, and weight, and to recover coded-wire tags. Tissue or otolith samples are also used to determine whether they are of hatchery or wild origin, and coded wire tags or otoliths may be used to identify strays from other systems. Depending on the accuracy required of such estimates, more sampling effort will be directed to gathering basic biological data to determine age and sex composition. State and tribal technical staff are currently focusing attention on the design and implementation of these studies.

Escapement surveys also describe the annual variation in the return timing of chinook populations. Given that terminal-area fisheries for chinook have been highly restricted or eliminated throughout Puget Sound, escapement surveys are increasingly relied on to monitor run timing, as well as age composition.

7.1.3 Reconstructing Abundance and Estimating Exploitation Rates

Estimates of spawning escapement and its age composition, and of fishery exploitation rates enable reconstruction of cohort abundance. After adjustment to account for non-landed and natural mortality, these estimates of recruitment define the productivity of specific populations. The principal intent of the current chinook harvest management regime is to set management unit objectives based on the current productivity of their component populations. These objectives will change over time, therefore, in response to change in productivity.

Indicator stocks, using local hatchery production, have been developed for many Puget Sound populations, as part of a coast-wide program established by the Pacific Salmon Commission. These include Nooksack River early, Skagit River spring, Stillaguamish River summer, Green River fall, Nisqually River fall, Skokomish River fall, and Hoko River fall stocks. Additional indicator stocks are being developed for Skagit River summer and fall, and Snohomish summer stocks. To the extent possible, indicator stocks have the same genetic and life history characteristics as the wild stocks that they represent. Indicator stock programs are intended to release 200,000 tagged juveniles annually, so that tag recoveries will be sufficient for accurate estimation of harvest distribution and fishery exploitation rates.

Commercial and recreational catch in all marine fishing areas in Washington is sampled to recover coded-wire tagged chinook. For commercial fisheries, the objective is to sample at least 20% of the catch in each area, in each statistical week, throughout the fishing season. For recreational fisheries, the objective is to sample 10% of the catch in each month / area stratum. These sampling objectives have been consistently achieved or exceeded in recent years (cite Milward or annual 2001 and 2002 annual reports). Mass marking of hatchery-produced chinook, by clipping the adipose fin, has necessitated electronic sampling of catch and escapement to detect coded-wire tags.

Coded-wire tag recovery data enables the calculation of total, age-specific fishing mortality in specific fisheries. These estimates of fishery mortality may be compared with those made by the fishery simulation model (FRAM) to check model accuracy. The FRAM may incorporate forecast or actual abundance and catch, which are scaled against base-year abundance and fisheries. It is recognized that the model cannot perfectly simulate the outcome of the coast-wide chinook fishing regime, so, periodically, the bias in simulation modeling will be assessed. The migration routes of chinook populations may vary annually, and the effect of changing fisheries regulations cannot be perfectly predicted in terms of landed or non-landed mortality.

Mark-selective fisheries, if implemented on a large scale, will exert significantly different landed and non-landed mortality rates on marked and unmarked chinook populations. Accurate post-season assessment of age- and fishery-specific harvest mortality, through a gauntlet of non-selective and mark-selective fisheries, represents a daunting technical challenge, particularly due to the complex age structure of chinook. Release of double index CWT groups (i.e. equal numbers of marked (adipose clipped) and unmarked fish containing distinct tag codes) has been initiated for many indicator stocks, as a means of maintaining the objectives of the coast-wide CWT indicator stock programs. Analyses are in progress to assess if the accuracy of exploitation rates is significantly reduced.

7.1.4 Smolt Production

Smolt production from several Puget Sound management units is estimated to provide additional information on the productivity of populations, and to quantify the annual variation in freshwater (i.e. egg-to-smolt) survival. Methods and locations of smolt trapping studies are described in detail elsewhere (e.g. Seiler et al. 2002, Patton 2003), but in general, traps are operated through the outmigration period of chinook (January – August). By sampling a known proportion of the channel cross-section, with experimental determination of trapping efficiency, estimates of the total production of smolts are obtained. These estimates are essential to understanding and predicting the annual recruitment, particularly in large river systems where freshwater survival has been shown to vary greatly. Abundance forecasts may incorporate any indications of abnormal freshwater survival

Survival of juvenile chinook is highly dependent on favorable conditions in the estuarine and near-shore marine zones. For many Puget Sound basins, degraded estuarine and near-shore marine habitat is believed to limit chinook production. Studies are underway to describe estuarine and early marine life history, and to quantify survival through the critical transition period as smolts adapt to the marine environment (Beattie 2002).

7.2 Annual Chinook Management Report

The co-managers will write an annual report on chinook fisheries management. Post-season review is part of the annual pre-season planning process, and is necessary to permit an assessment of the parties' annual management performance in achieving spawning escapement, harvest, and allocation objectives. The co-managers review stock status annually and where needed, identify actions required to improve estimation procedures, and correct bias. Such improvements provide greater assurance that objectives will be achieved in future seasons. Annual review builds a remedial response into the pre-season planning process to prevent excessive fishing mortality levels relative to the conservation of a management unit. The annual report will include:

Fisheries Summary
The chronology and conduct of all fisheries within the co-managers' jurisdiction will be summarized, comparing expected and actual fishing schedules, and landed chinook catch. Significant deviations from the pre-season plan will be highlighted, with a summary of in-season abundance assessments and changes in fishing schedules or regulations.

Catch
Landed catch of chinook in all fisheries during the management year (May – April) will be compared with pre-season expectations of catch, including revised estimates of landed catch for the previous management year. For the most recent management year, preliminary estimates of commercial catch from all fisheries will be reported. Creel survey-based estimates of recreational catch in Areas 1 – 6 will also be available. The causes of significant discrepancies between expected and actual catch will be examined, with a view to improving the accuracy of the pre-season projections.

Non-landed Mortality:
Recreational and troll fisheries typically allow retention of chinook above a minimum size, or prohibit retention of chinook during some periods. The ocean troll fishery has been monitored since 1999, using on-board observers and fishers to collect data on encounters with sub-legal chinook. These studies enable comparison of encounters, and consequent mortality, with pre-season expectations.

Spawning Escapement
Spawning escapement for all management units will be compared to pre-season projections, with detail on individual populations reported as possible. Escapements will be compared to escapement goals and critical escapement thresholds. Final and detailed estimates of escapement for the previous year will also be tabulated.

Sampling Summary
The annual review will also include summary of CWT sampling rates achieved in the previous year, and describe biological sampling (i.e., collection of scales, otoliths, and sex and size data) of catch and escapement.

Exploitation Rate Assessment
Annual, adult equivalent exploitation rates for each management unit will be estimated periodically, using the FRAM, incorporating actual chinook catch from all fisheries, and estimates of the actual annual abundance of all chinook units, based on spawning escapement or terminal abundance. These rates will be compared to the preseason expected ER's and ceiling ER's. The 2002 annual report will include post-season FRAM estimates through 2000. Methods are also being developed for assessing annual exploitation rates, for management units with representative indicator stocks, based on coded-wire tag data.

ISBM Index Rates:
The annual report will summarize the Chinook Technical Committee's assessment of whether non-ceiling fishery exploitation rates for indicator management units achieved the PST benchmarks (either 60% of the 1979-1982 mean non-ceiling rate or the 1991-1996 average reduction compared with that base period), for units failing to achieve agreed escapement goals for two consecutive years

The following assessments will be done every 5 years:

Cohort Reconstruction and Exploitation Rate (from CWT data)
Coded-wire tag data will be used to reconstruct brood year AEQ recruitment and exploitation rates for management units with representative indicator stocks, for the five most recently completed broods with complete data. Because coded-wire tag recoveries require at least one year to process and record, estimates for a given brood year will be made six years later, (i.e. after the brood is completely matured).

Comparison to FRAM
The AEQ fishing year and brood year exploitation rates generated from coded-wire tag data will be compared to the corresponding rates estimated annually from post-season runs of the assessment model. Biases will be examined and either accounted for or corrected in future management.

Spawner-Recruit Parameters
The spawner-recruit parameters used to generate the ceiling ER's, thresholds, and recovery goals will be re-examined by including the most recent data on escapement, juvenile production, habitat productivity, marine survival, and recruitment. As appropriate, the ceiling ER's, thresholds, and recovery goals will be updated to account for changes in productivity.

7.3 Spawning Salmon – A Source of Marine-derived Nutrients

Adult salmon provide essential marine-derived nutrients to freshwater ecosystems, as a direct food source for juvenile or resident salmonids and invertebrates, and as their decomposition supplies nutrients to the food web. A body of scientific literature, reviewed in Appendix D, supports the contention that the nutrient re-cycling role played by salmon is particularly important in nutrient-limited, lotic systems in the Northwest. Some studies assert that declining salmon abundance and current spawning escapement levels exacerbate nutrient limitation in many systems. Controlled experiments to test the effect of fertilizing stream systems with salmon carcasses or nutrient compounds show increased primary and secondary productivity, and increased growth rates of juvenile coho and steelhead.

The question this issue poses to chinook harvest management is whether the management objectives stated in this Plan will result in spawning escapement levels that, in fact, are likely to cause or exacerbate nutrient limitation, and thus negatively influence the growth and survival of juvenile chinook, or otherwise constrain recovery of listed populations. Several aspects of this issue are relevant to determining whether such negative influence exists

The role of adult chinook must be examined in the context of escapement (i.e. nutrient potential) of all salmon species. In the large river systems that support chinook, escapements of pink, coho, and chum salmon comprise a large majority of total nutrient input. Changing chinook escapement, therefore, will not increase nutrient loading significantly.

The fertilizing influence of salmon carcasses on chinook depends on a complex array of factors, including their proximity to chinook rearing areas, the influence of flow and channel structure on the length of time carcasses are retained, and chinook life history.

Harvest management strategy must be informed by credible direct or circumstantial evidence indicating that chinook survival is currently limited by nutrient supply.

Post-emergent survival of juvenile chinook is undoubtedly affected by a complex array of other biotic and physical factors. The incidence and magnitude of peak flow during the incubation season, for example, is correlated very strongly with outmigrant smolt abundance in the Skagit River and other Puget Sound systems (Seiler et al. 2000).

Currently available evidence does not support the contention that increasing escapement goals, for chinook or other species, would likely to result in higher chinook abundance or, in the long term, increased harvestable surplus. Under exploitation rate management, which this Plan describes for several management units, escapement will increase as abundance increases. These principles have been in effect since 1998, and increases in escapement have resulted in some systems. This has the same effect as increasing the escapement goal.

The nutrient benefit of increased escapement affects, predominantly, smolt production from that brood year, especially for chinook populations that outmigrate as sub-yearlings. Spawner – recruit analyses will reflect the potential effect of nutrient loading on productivity. Regular updating of the spawner – recruit function is mandated by this plan, and will detect changes in productivity that result from widely variable, and in some systems, increasing, nutrient loading associated with spawning escapement of all salmon.

Unquestionably, further study of the potential for nutrient limitation of chinook growth and survival is warranted. Studies should be designed and implemented to test nutrient limitation hypotheses in several chinook-bearing systems, and in smaller tributary systems that allow controlled experimental design. These studies should include monitoring secondary production of aquatic macroinvertebrates, fingerling condition, smolt abundance and survival to adulthood under controlled conditions to allows isolation of the effect of carcass nutrient loading. They will be difficult to design and implement, such that results are clear and unconfounded by the complexity of physical factors and trophic dynamics freshwater systems. Such studies may, ultimately, lead to quantifying nutrient loading thresholds where effects on chinook growth and survival are evident, to guide harvest management.

Manipulating spawning escapement, or supplementing nutrient loading with surplus hatchery returns will require resource management agencies to consider benefits and potential negative effects from a wider policy perspective. Artificial nutrient supplementation, despite its potential benefits to salmon production, contradicts the long-standing effort to prevent eutrophication of freshwater systems. Use of surplus carcasses from hatcheries also has serious potential implications for disease transmission. Public policy will, therefore, have to be carefully crafted to meet potentially conflicting mandates to protect water quality and restore salmon runs (Lackey 2003).

7.4 Age- and Size-Selective Effects of Fishing

Commercial and recreational salmon fisheries exert some selective effect on the age, size, and sex composition of mature adults that escape to spawn (Appendix F). When and where fisheries operate, the catchability of size and age classes of fish associated with different gear types, and the intensity of harvest determine the magnitude of this selective effect. In general, hook-and-line and gillnet fisheries are thought to selectively remove older and larger fish. To a certain extent related to the degree to which age at maturity and growth rate are genetically determined, subsequent generations may composed of fewer older-maturing or faster growing fish. Fishery-related selectivity has been cited as contributing to long-term declines in the average size of harvested fish, and the number of age-5 and age-6 spawners. Older, larger female spawners are believed to produce larger eggs, and dig deeper redds, which improve survival of embryos and fry. .

There is no evidence of long-term or continuing trends in declining size or age at maturity for Puget Sound chinook.. Available data suggest that the fecundity of mature Skagit River summer chinook has not declined from 1973 to the present. (Orrell 1976; SSC 2002). The age composition of Skagit summer / fall chinook harvested in the terminal area has varied widely over the last 30 years, particularly with respect to the proportions of three and four year-old fish, but there is no declining trend in the contribution of five year-olds, which has averaged 15 percent (Henderson and Hayman 2002; R. Hayman, SSC December 9, 2002, pers comm.)

7.5 Amendment of the Harvest Management Plan

The Plan will continue to evolve. Harvest objectives will change in response to change in the status and productivity of chinook populations. It is likely that the assessment tools will evolve to improve estimation of spawning escapement and cohort abundance. Data gaps are identified for each management unit in their profiles (Appendix A). As these new data accumulate, the co-managers will periodically re-assess harvest objectives for all management units. In general this will occur on a five-year cycle, unless information suggests that rapidly changing status demands more frequent attention.

8. Glossary

Abundance - Abundance is the number of individuals comprising a population or a component of the population, at a given life stage. Abundance may be expressed as brood year escapement (spawners of all ages that survive from one brood year) or return year escapement (the individuals maturing and returning to spawn in a single year). Abundance goals are expressed as numeric life stage targets reflective of the capacity of the associated ecosystem.

Adult Equivalent (AEQ) - The adjustment of fishing mortality to account for the potential contribution of fish of a given age to the spawning escapement, in the absence of fishing. Because not all unharvested fish will survive to contribute to spawning escapement, a two-year-old chinook has a lower probability of surviving to spawn, in the absence of fishing, than does a five-year-old.

Catch Ceiling - A fishery catch limitation expressed in numbers of fish. A ceiling fishery is managed so as not to exceed the ceiling. A ceiling is not an entitlement. [see also **catch quota**]

Catch Quota - A fishery catch allocation expressed in numbers of fish. A quota fishery is managed to catch the quota; actual catch may be slightly above or below the quota. [see also **catch ceiling**]

Cohort Analysis - Reconstruction of the abundance of a population or management unit prior to the occurrence of any fishing mortality. The calculation sums spawning escapement, fisheries-related mortality, and adult natural mortality.

Cohort Size (initial) - The total number of fish of a given age and stock at the beginning of a particular year of life.

Coded-Wire Tag (CWT) - Microtags are implanted in juvenile salmon prior to their release from hatcheries. Recovered by sampling catch and escapement, the binary code on the tag provides specific information about the age and origin of the fish.

Low abundance threshold - A spawning escapement level, set intentionally above the point of biological instability, which triggers extraordinary fisheries conservation measures to minimize fishery related impacts and increase spawning escapement.

Diversity - Diversity is the measure of the heterogeneity of the population or the ESU, in terms of the life history, size, timing, and age structure. It is positively correlated with the complexity and connectivity of the habitat.

Drop-off Mortality - The fraction of salmon encountered by a particular gear type that "drop-off" before they are landed, and die from their injuries prior to harvest or spawning.

Escapement – Adult salmon that survive fisheries and natural mortality, and return to spawn.

Evaluation or Test Fishery - A fishery scheduled specifically to obtain technical or management information, e.g. run timing, abundance, and age composition.

Exploitation Rate (ER) - Total mortality in a fishery or aggregate of fisheries expressed as the proportion of the sum of total mortality plus escapement.

Extreme Terminal Fishery – A fishery in freshwater that is assumed to harvest fish from the local management unit.

Fishery – Harvest by a specific gear type in a specific geographical area during a specific period of time.

FRAM - The Fishery Regulation Assessment Model is a simulation model developed to estimate the impacts of Pacific Coast fisheries on chinook and coho stocks.

Gamma Distribution - The gamma distribution is member of the exponential family of distributions. Values of the gamma distribution are positive, ranging from zero to infinity, a property which makes it attractive for modeling variances. Shape and scale parameters describe the distribution.

Harvest Rate (HR) **-** Total fishing mortality of a given stock expressed as a proportion of the total fish abundance available in a given fishing area at the start of a time period.

Landed Catch – Harvested fish that are taken aboard vessels or shore and retained by fishers. [see also **Nonlanded Mortality**]

Management Period – Based on information about migration timing, the management period is the time interval during which a given species or management unit may be targeted by fishing in a specified area. [see also **Management Unit**]

Management Unit - A stock or group of stocks that are aggregated for the purpose of achieving a management objective.

Maximum Sustainable Harvest (MSH) - The maximum number of fish of a management unit that can be harvested on a sustained basis, that will result in a spawning escapement level that optimizes productivity.

MSH Exploitation Rate – The maximum sustainable harvest (MSH) exploitation rate is the proportion of the stock abundance that could be harvested if long-term yield was to be maximized. The MSH exploitation rate is typically computed assuming stable stock productivity, although annual variability may occur.

Non-landed Mortality – Fish not retained that are otherwise killed as a result of encountering fishing gear. It includes a proportion of sub-legal fish that are captured and released, hook-and line drop-off, and net drop-out mortality. [see **Landed Catch**]

Non-treaty Fisheries - All fisheries that are not treaty Indian fisheries. [see **Treaty Fisheries**]

North of Cape Falcon Forum– A pre-season, management planning process for fisheries in Washington and Oregon, consisting of two public meeting, which occur between the March and April Pacific Fishery Management Council meetings. These meetings provide for an opportunity for discussion, analysis and negotiation among management entities with authority over southern US fisheries.

Parties - The State of Washington and 17 Puget Sound tribes comprise the parties to this plan.

Point of instability - that level of abundance (i.e., spawning escapement) that incurs substantial risk to genetic integrity, or exposes the population to depensatory mortality factors.

Pre-terminal Fishery- A fishery that harvests significant numbers of fish from more than one region of origin.

Productivity - Productivity is the ratio of the abundance of juvenile or adult progeny to the abundance of their parent spawners

Recruitment – Production, quantified at some life stage (e.g. smolts or sub-adults) from a single parent brood year.

Run Size - The number of adult fish in an allocation unit, management unit, stock or any aggregation thereof that is subject to harvest in a given management year.

Shaker Mortality - Nonlanded fishing mortality that results from releasing sub-legal fish, or non-target species. [see **Nonlanded Mortality**]

Southern US Non-Ceiling Index – The index compares the expected AEQ mortalities (assuming base period exploitation rates and current abundance) with the observed AEQ mortalities, by calendar year, over all non-ceiling fisheries in southern US. This index originates from the pass through provision of the Pacific Salmon Treaty.

Stock - a group of fish of the same species that spawns in a particular lake or stream (or portion thereof) at a particular season and which, to a substantial degree, does not interbreed with fish from any other group spawning in a different place or in the same place at a different season.

Terminal Fishery - A fishery, usually operating in an area adjacent to or in the mouth of a river, which harvests primarily fish from the local region of origin, but may include more than one management unit. Non-local stocks may be present, particularly in marine terminal areas.

Treaty Fisheries - Fisheries authorized by tribes possessing rights to do so under the Stevens treaties (see also **Non-treaty Fisheries).**

Tribes - Puget Sound treaty tribes that are parties to this Plan include the: Lummi, Nooksack, Swinomish, Upper Skagit, Sauk-Suiattle, Tulalip, Stillaguamish, Muckleshoot, Suquamish, Puyallup, Nisqually, Squaxin Island, Skokomish, Port Gamble S'Klallam, Jamestown S'Klallam, Lower Elwha Klallam, and Makah.

Viable – In this plan, this term is applied to salmon populations that have a high probability of persistence (i.e. a low probability of extinction) due to threats from demographic variation, local environmental variation, or threats to genetic diversity. This meaning differs from that used in some conservation literature, in which viability is associated with healthy, recovered population status (see McElhany et al. 2000).

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